# THE ENGINEER

JUNE 24, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

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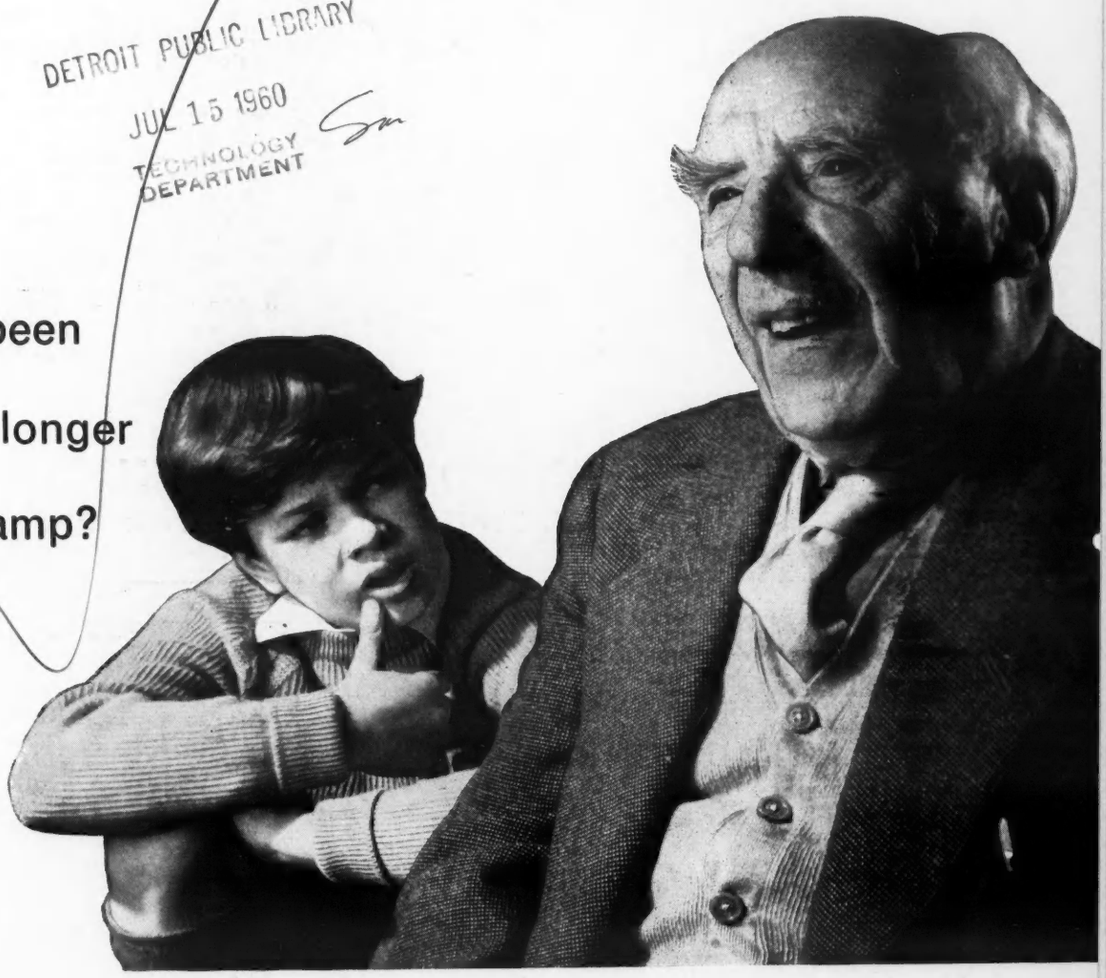
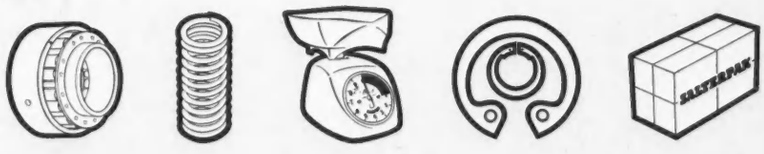


Age alone has little to commend it but there is no substitute for experience. After two hundred years of continuous progress Salter are in an outstanding position to serve the homes and industries of today.

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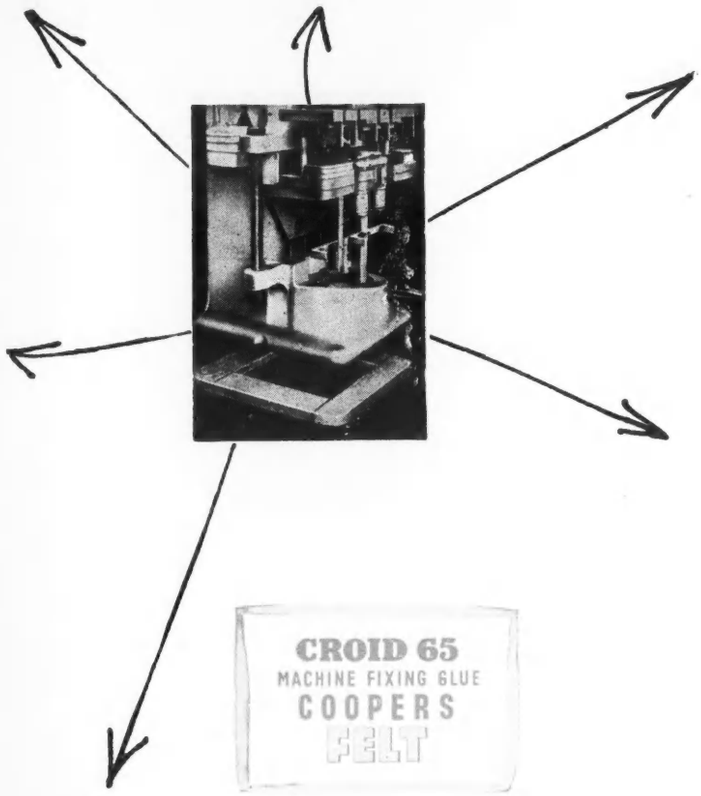


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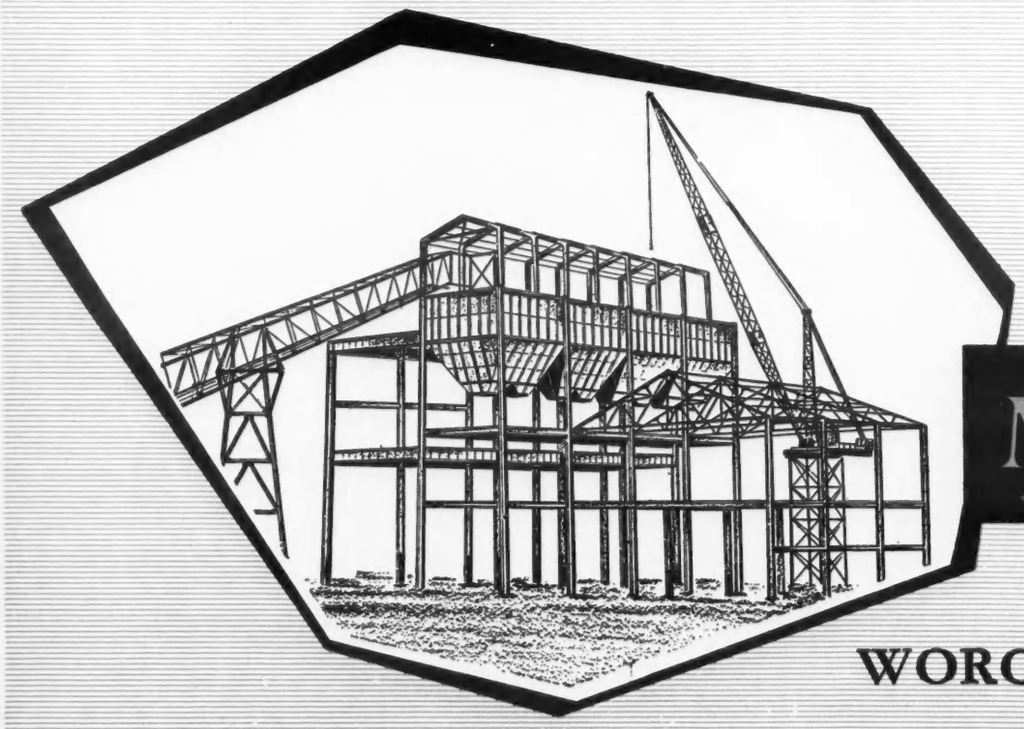

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# THE ENGINEER

*Established* 1856

No. 5448 JUNE 24, 1960 VOL. 209

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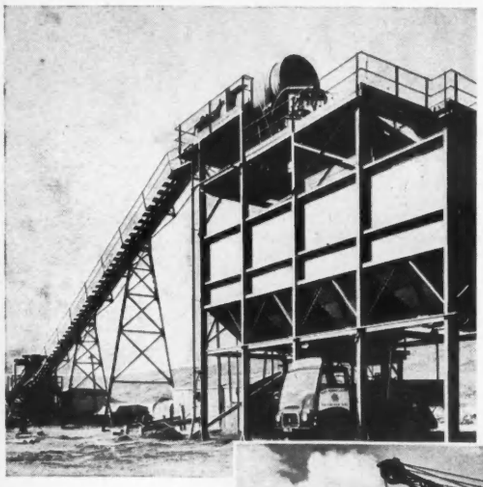

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*A day later this plant was working miles away.*

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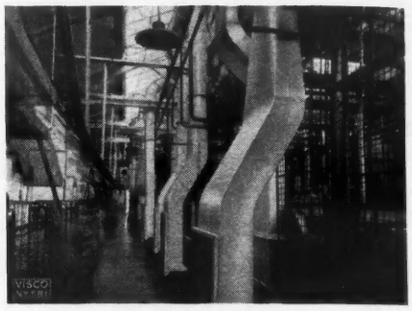
Visco Ventilating and Air Conditioning Plant is especially designed for the varying requirements of all branches of Industry.

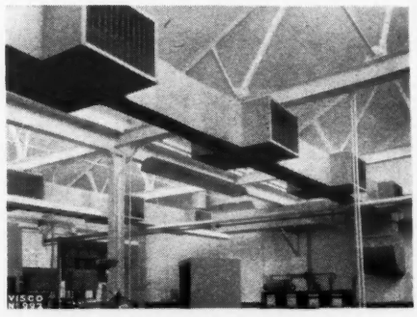


*Ventilation Plant—Walton & Brown Ltd.*

## Ventilation, Fume Removal

### Fume Removal

VISCO deal directly with noxious fumes and are used by leading industries for fume removal and air treatment installations.



*Air Conditioning Plant—The General Electric Co. Ltd.*

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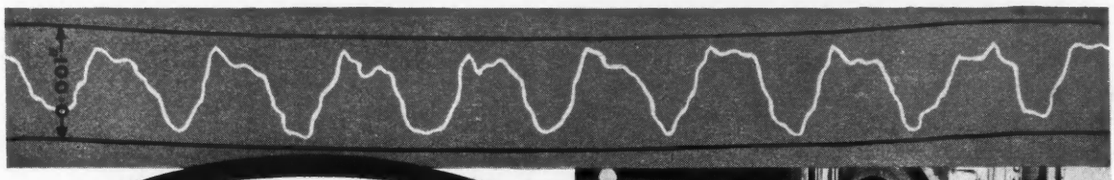
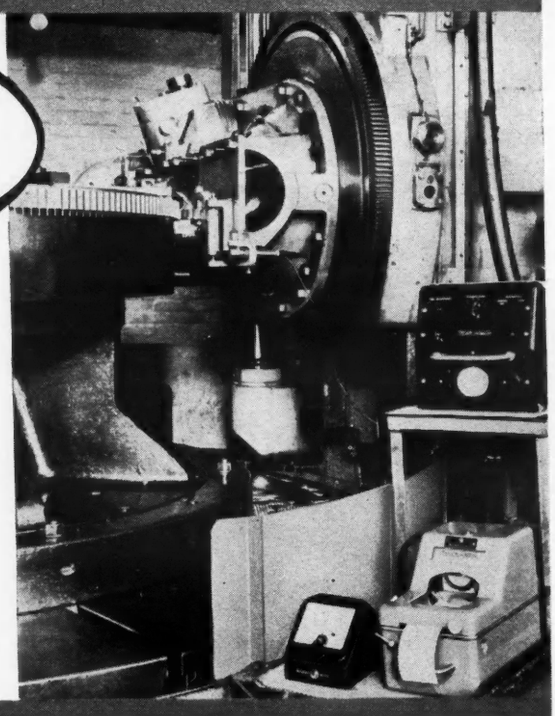
# PRECISION GEAR-CUTTING




## Here's proof of real precision

**—better than Admiralty Class 1 Specification**

The diagram shows a composite-error record (in part) of a precision-hobbed 4 D.P. spur ring of 56.250-in. P.C.D. Photograph shows gear ring on hobbing machine after cutting, with master gear spring-loaded in close mesh, and error record being taken. *Total error over 225 teeth—including master gear error—0.0012 in.*



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*For full particulars of this AEI service please write to Gear Sales, Rugby.*

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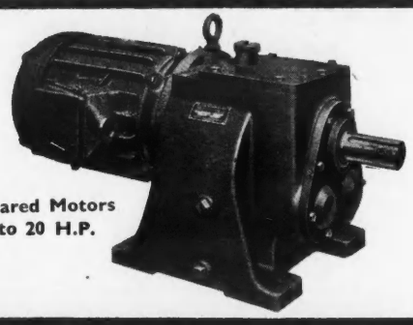
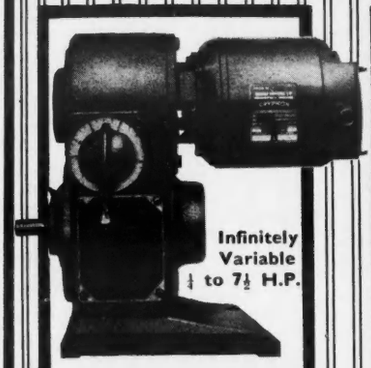


Geared Motors
¼ to 20 H.P.



Infinitely Variable
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"½ H.P"
10 to 50 r.p.m.

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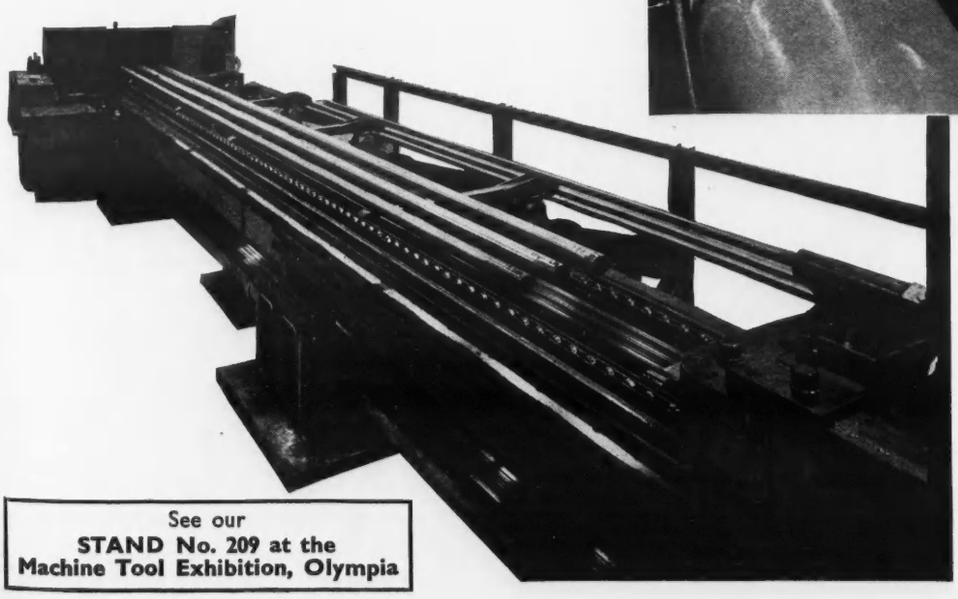

See our
**STAND No. 209 at the Machine Tool Exhibition, Olympia**

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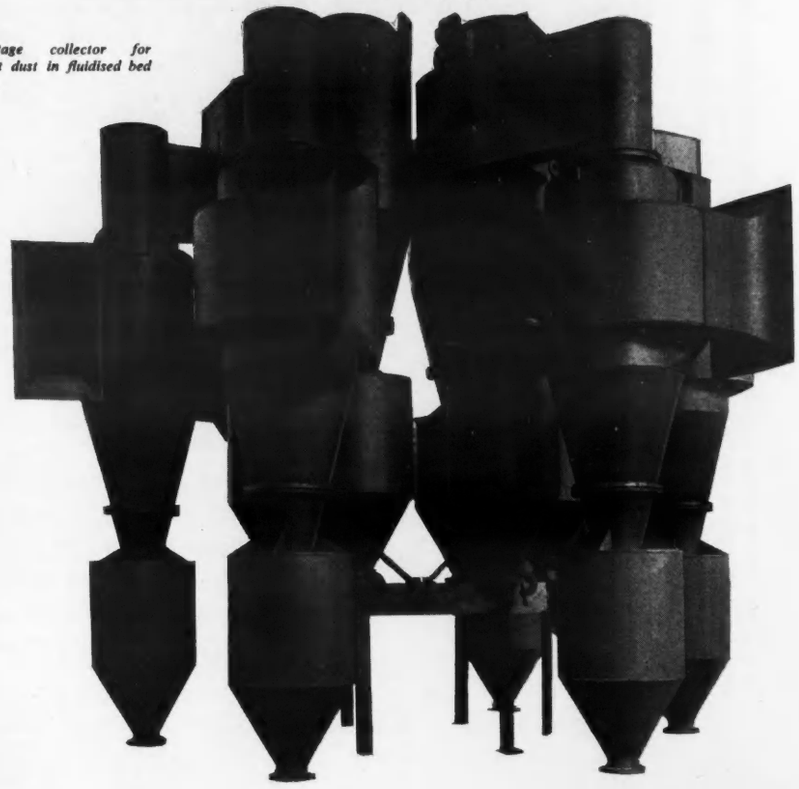
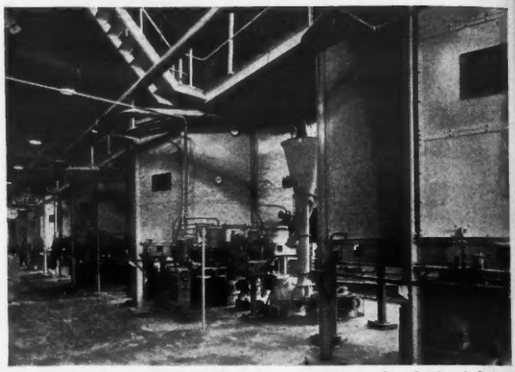
Trade Mark

## for dust extraction and industrial drying...



*Multi-stage collector for Catalyst dust in fluidised bed reactor.*

We design and supply complete dust separation plants incorporating Buell high-efficiency cyclones (Van Tongeren System). Also complete installation for the economical and efficient drying of material, incorporating Buell (Büttner) Rotary Drum or 'Turbo' Tray Dryers. Full information in our leaflets - "Drying Equipment" and "Dust Collection".



*An installation of Buell Turbo Dryers supplied to the plastics industry*

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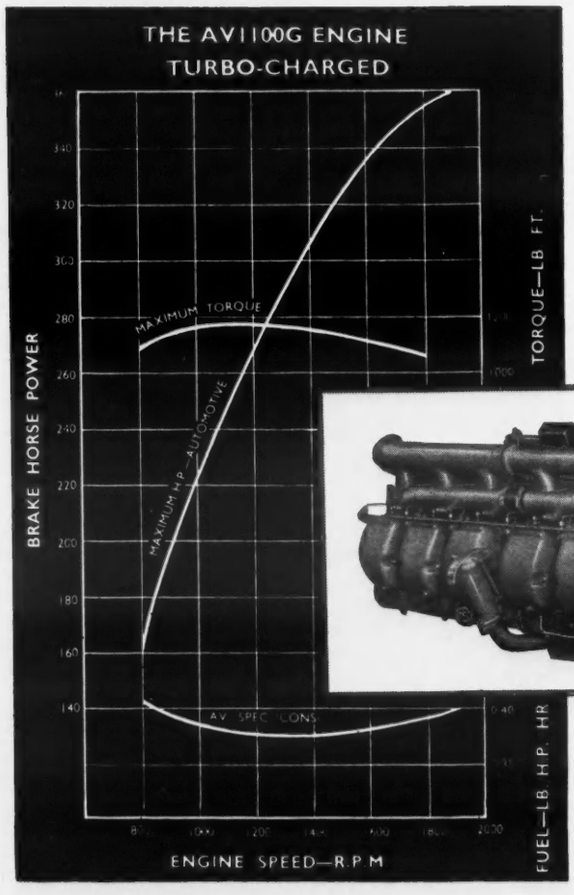
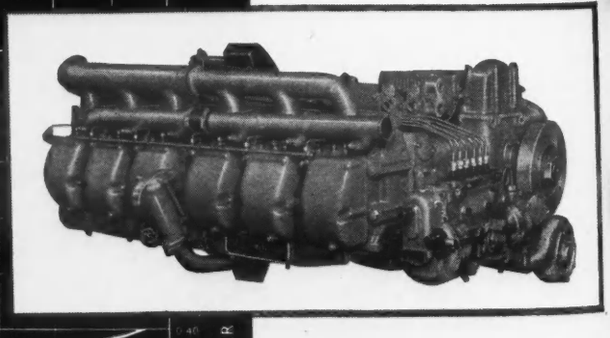
Every A.E.C. diesel has behind it the experience of nearly 30 years in diesel design and production, and a world-wide service and spares organisation that never sleeps.




*The AH100G horizontal Industrial Diesel*



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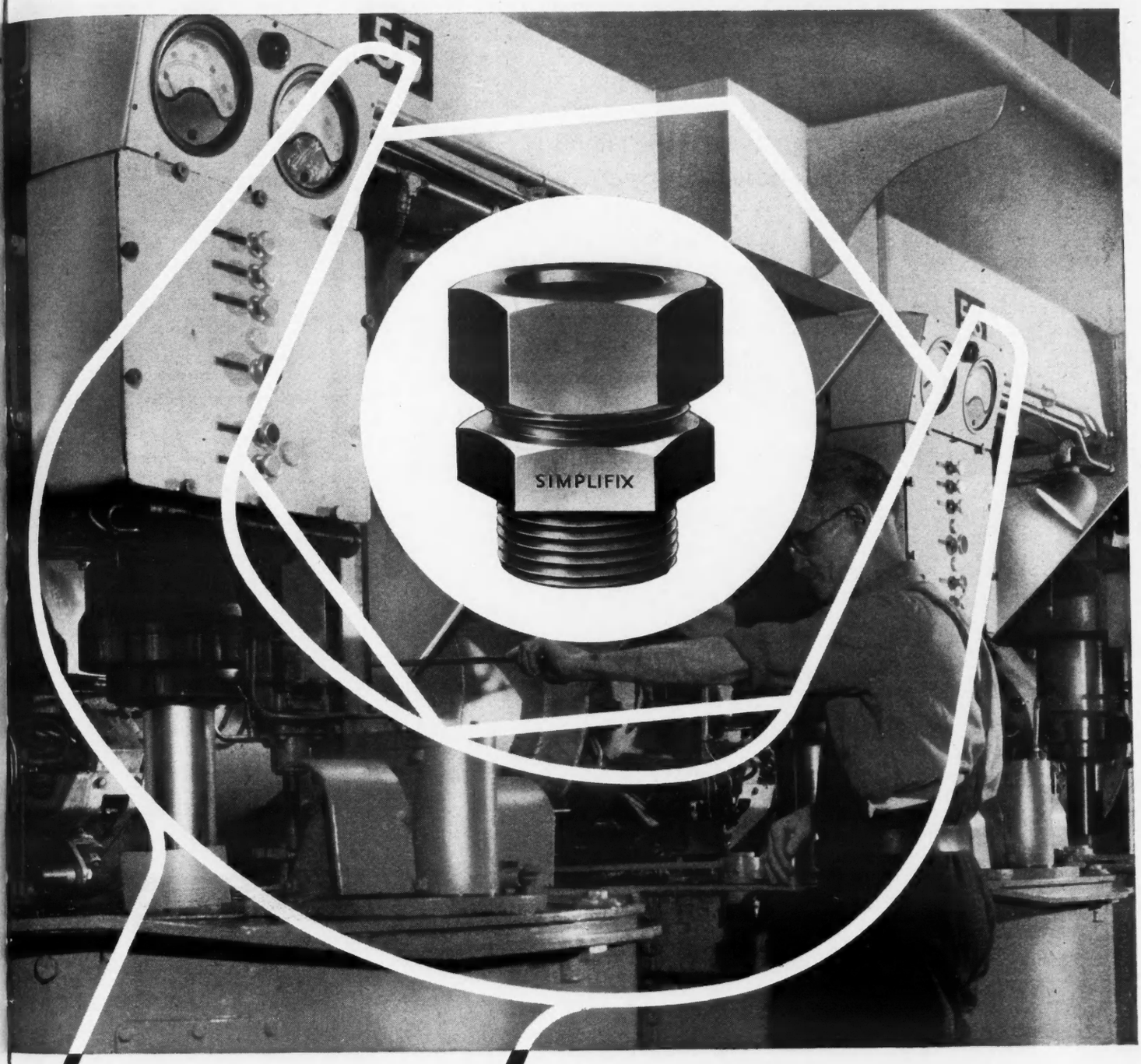


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*The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.*

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* Natural rubber, heavy gauge, seamless tube.
* Manufactured in 60 ft. lengths.
* High tensile wire-braid reinforcement with special spiral asbestos cord which incorporates a static conducting wire.
* Light-weight yet of great strength.
* Neoprene cover, compounded to withstand extreme heat and abrasion.

Specially designed for high-pressure operations, this wire-braid hose handles 200 lbs. p.s.i. The spiral asbestos cord with static conducting wire is incorporated for additional safety. This is one of the many types of hose for general industrial use, backed by the world-wide experience of U.S. Rubber, manufactured at Edinburgh in Europe's most modern plant. Robust, reliable and efficient, each in its category is unequalled value for all-round service and economical operation.

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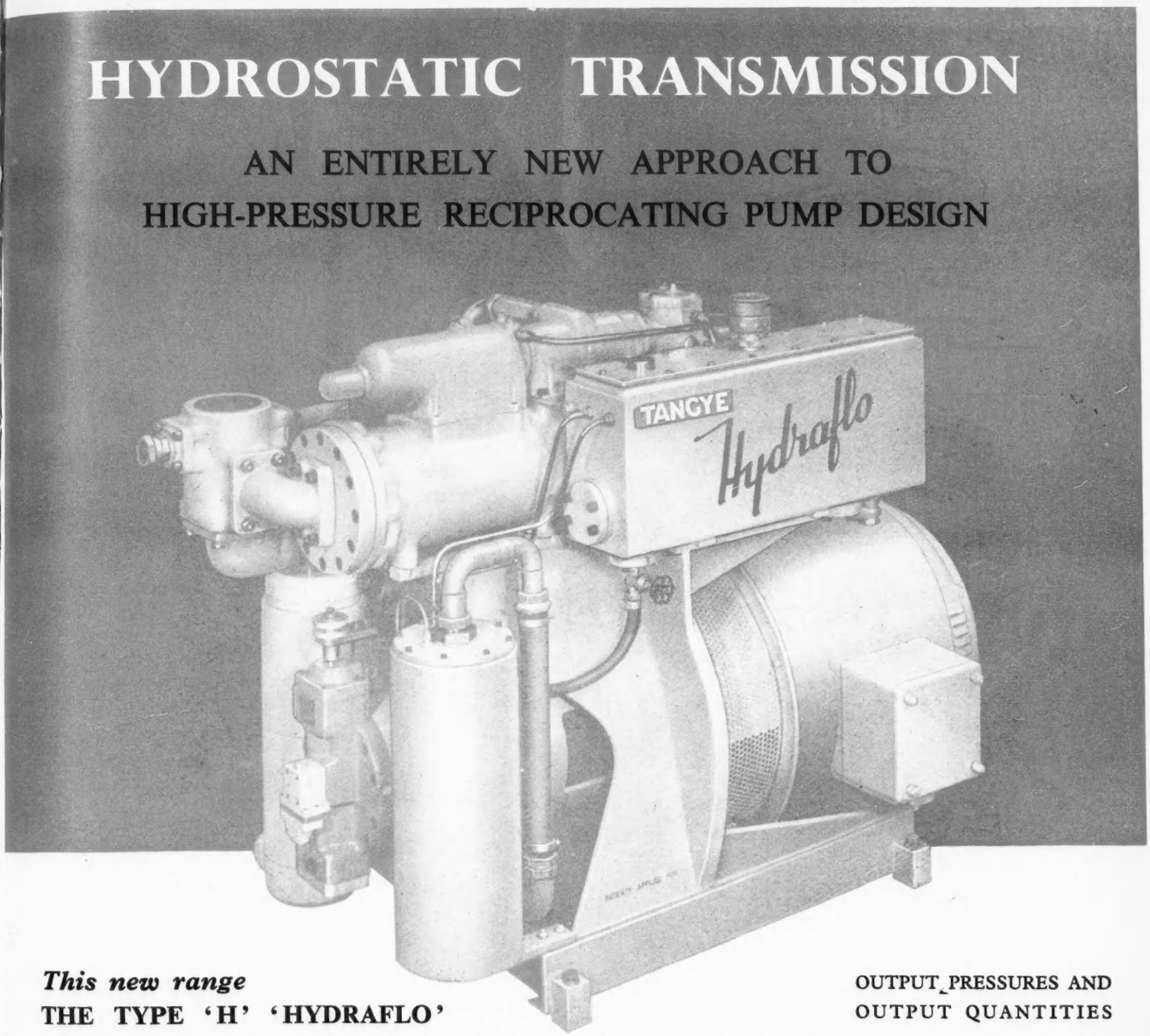


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The duty range of the pumps covers output pressures up to 9,000 lbs. p.s.i. (when the output quantity would be about 10 gals. per min.) and output quantities up to 75 gals. per min., (when the output pressures obtainable would be in the region of 1200 lbs. p.s.i.). Powers available are up to 90 H.P. input.

A COMPREHENSIVE DESCRIPTION OF THIS NEW RANGE IS AVAILABLE

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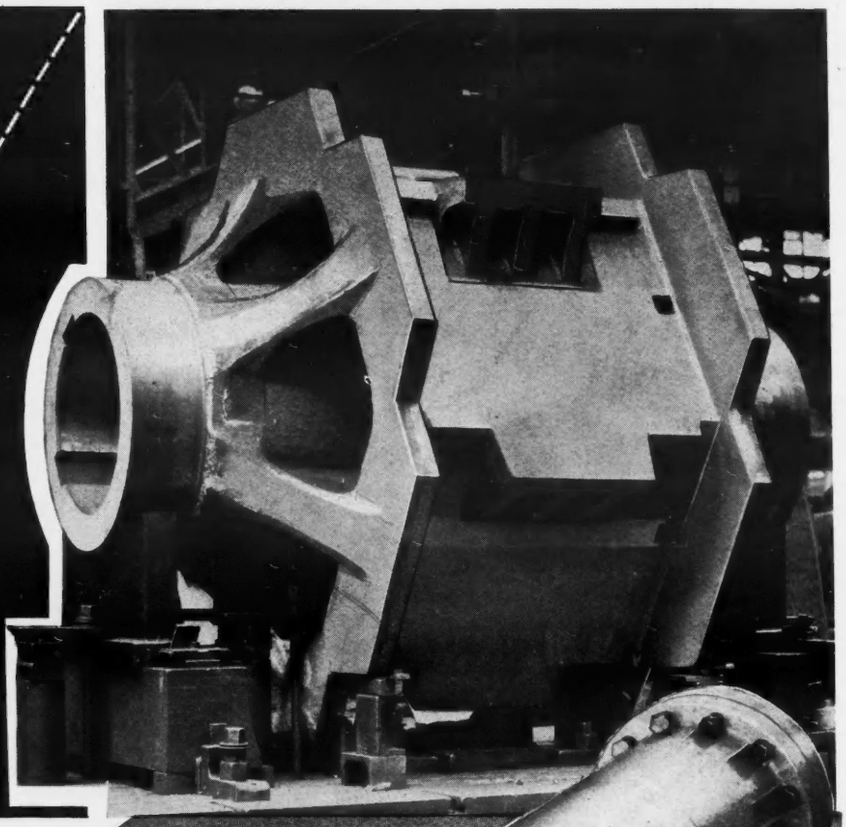
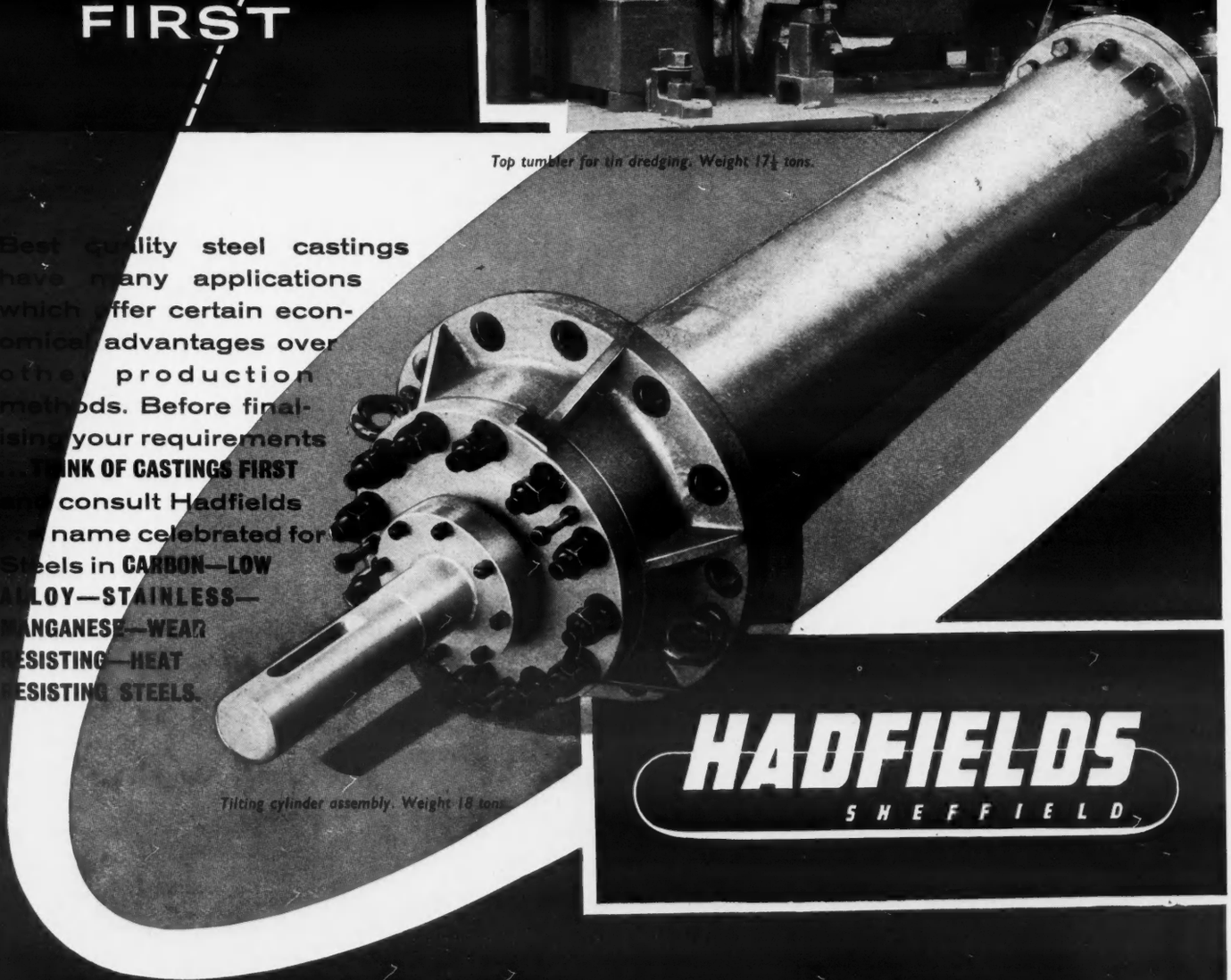
# THINK OF STEEL FIRST



Top tumbler for tin dredging. Weight 17½ tons.

Best quality steel castings have many applications which offer certain economical advantages over other production methods. Before finalising your requirements **THINK OF CASTINGS FIRST** and consult Hadfields the name celebrated for Steels in **CARBON—LOW ALLOY—STAINLESS—MANGANESE—WEAR RESISTING—HEAT RESISTING STEELS.**



Tilting cylinder assembly. Weight 18 tons.

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## to increase output

## with 40% less machining time & 12% less material used

**Modern steel foundries have many techniques for manufacturing economically to a high degree of accuracy.**

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Broomgrove Lodge, Broomgrove Road, Sheffield.

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STEEL CASTINGS

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**from 3″ size upwards**

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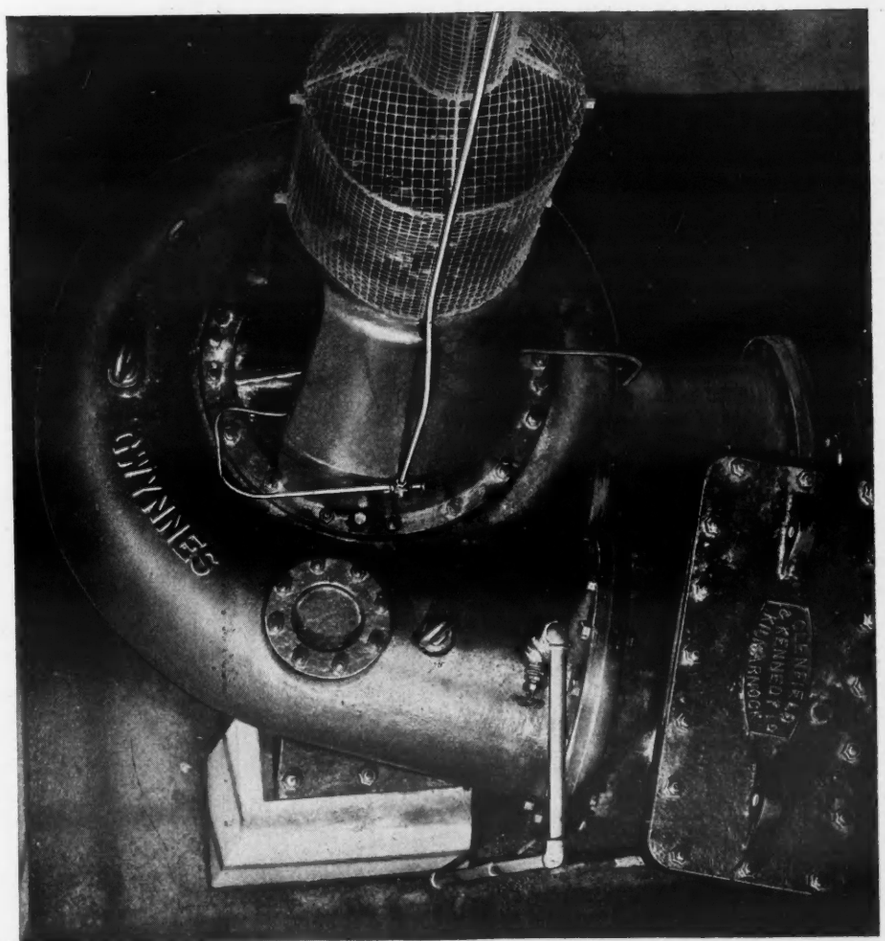


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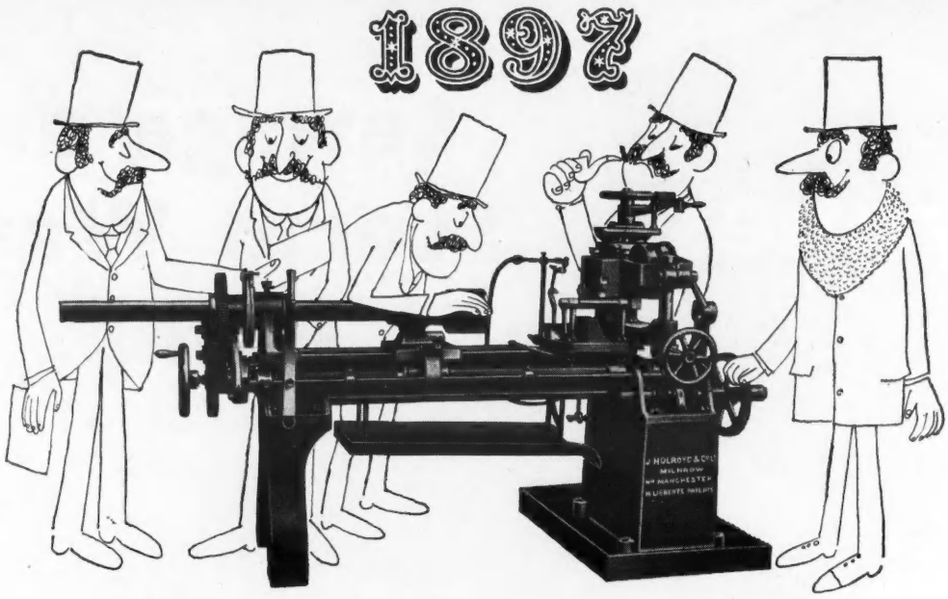


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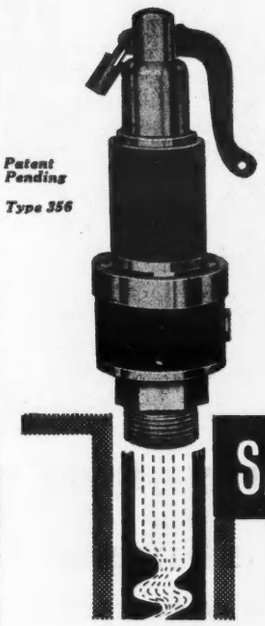

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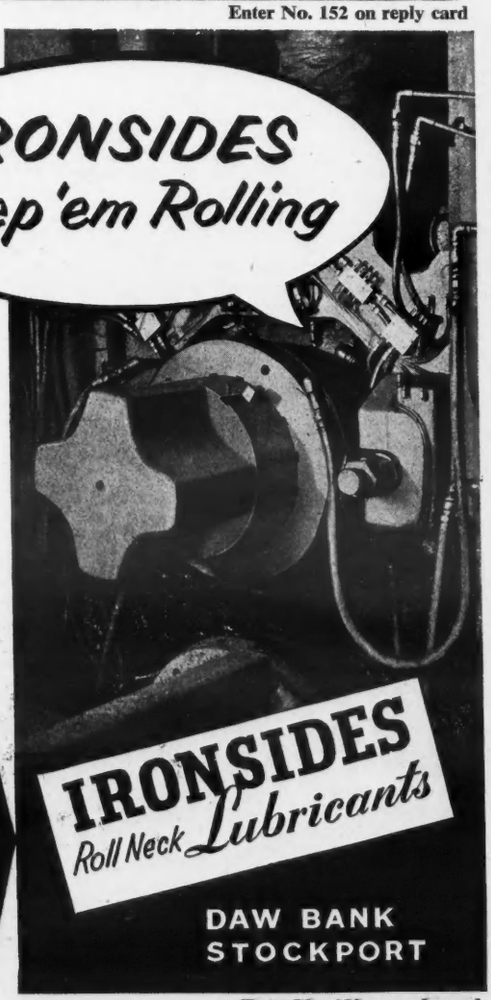

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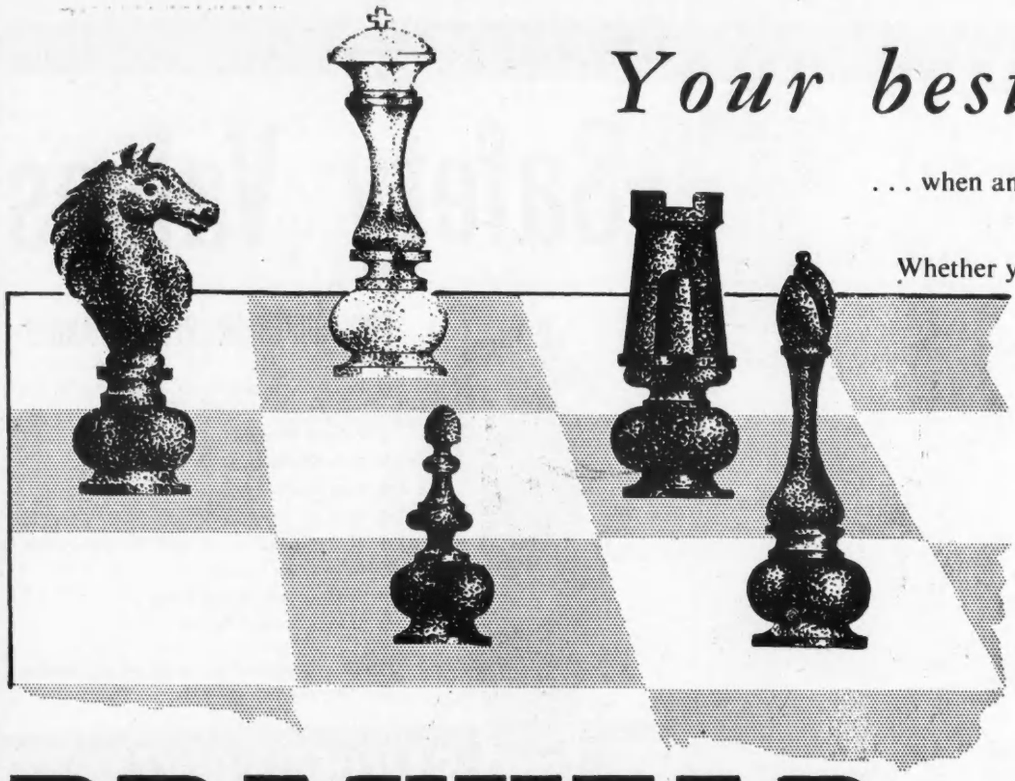

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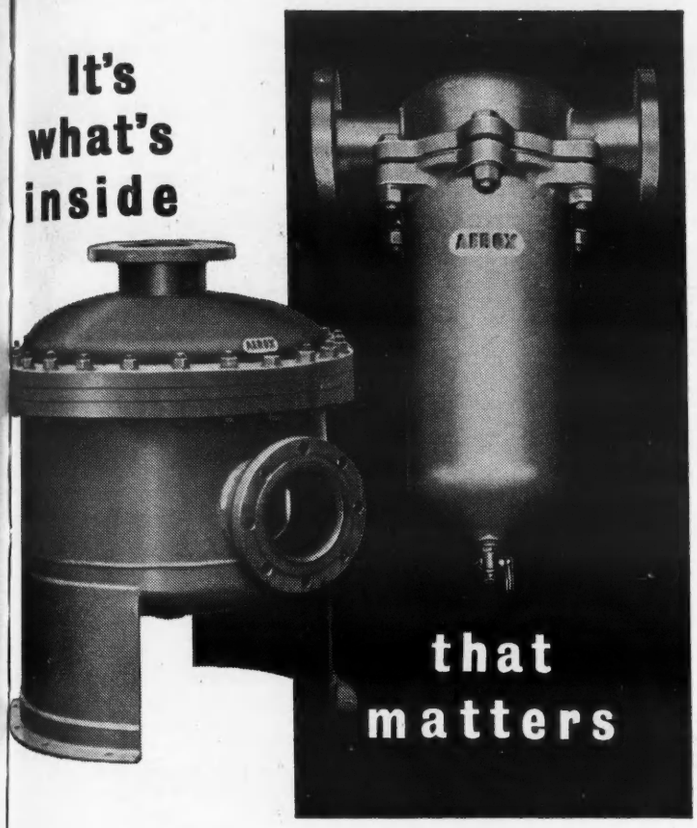


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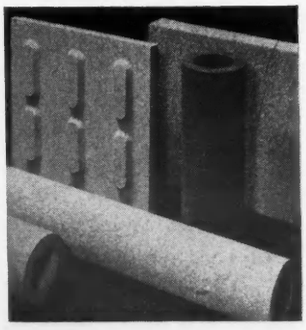

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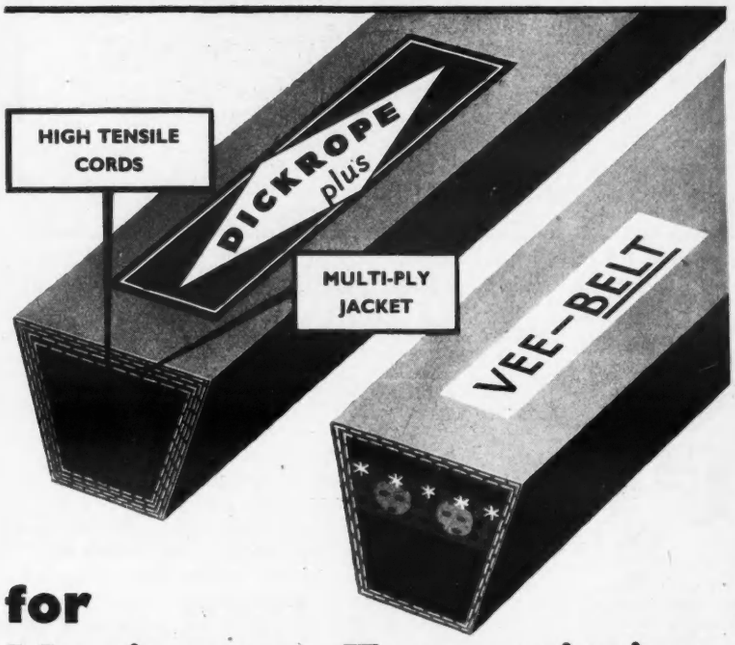


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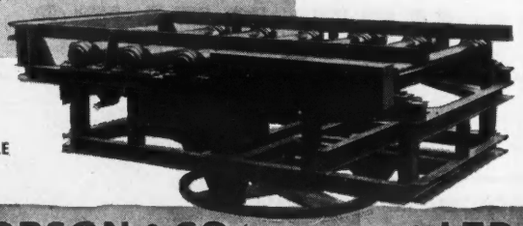

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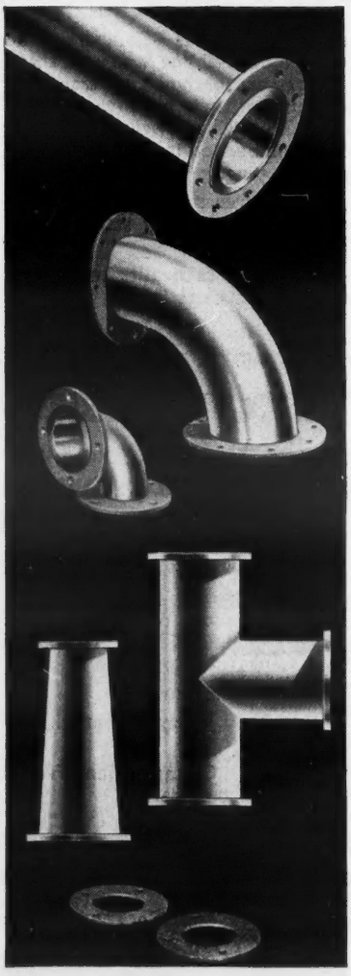

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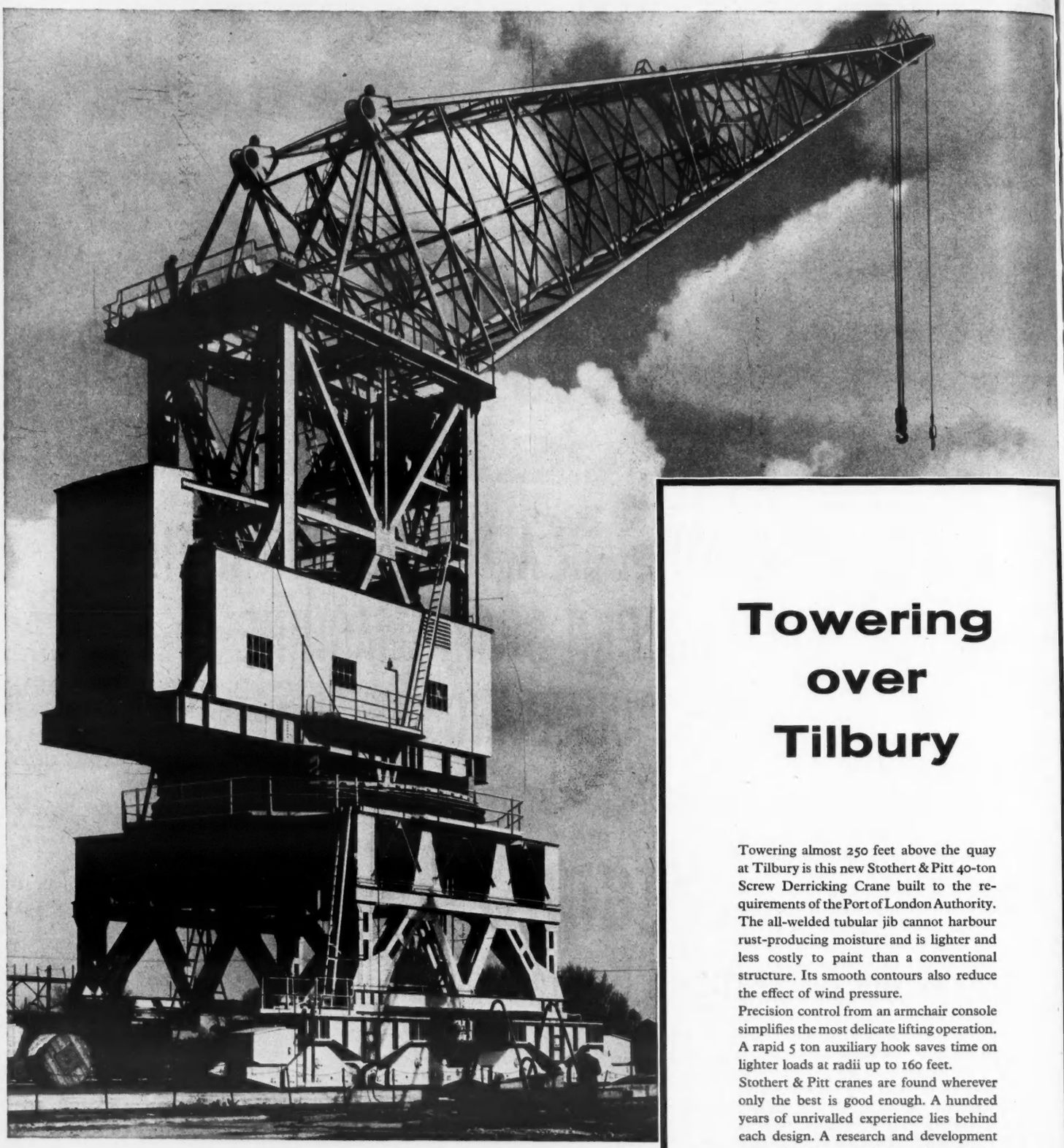

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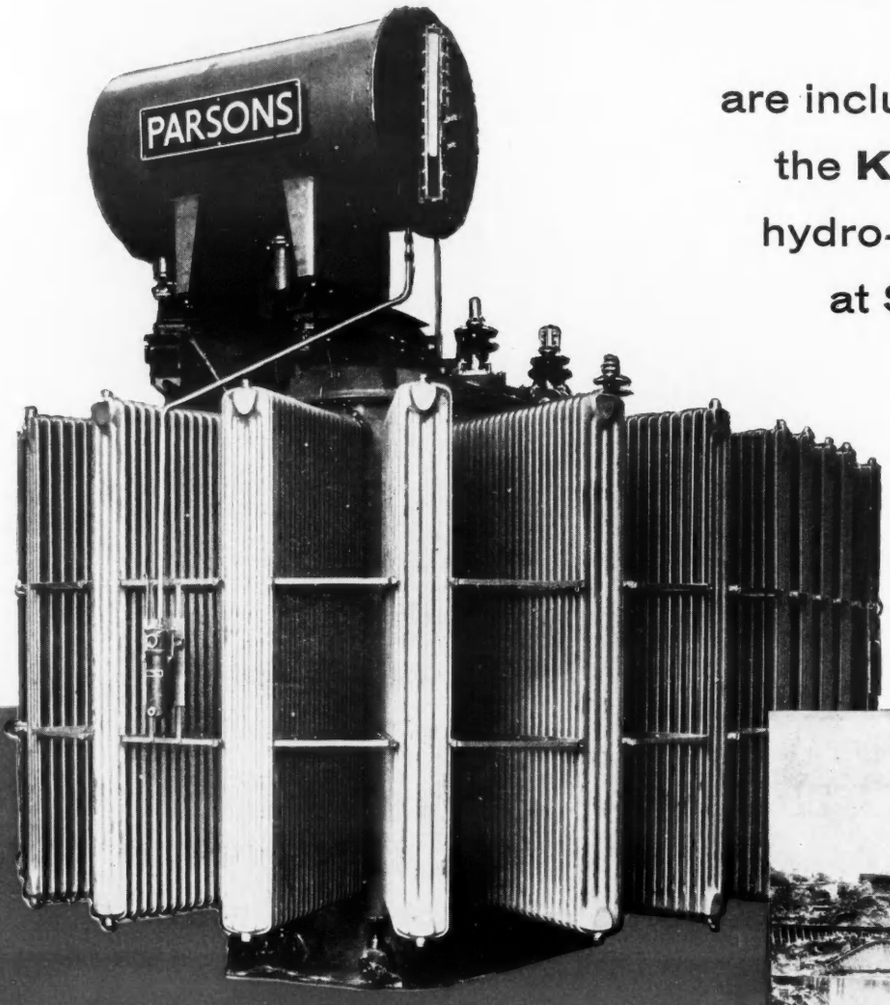


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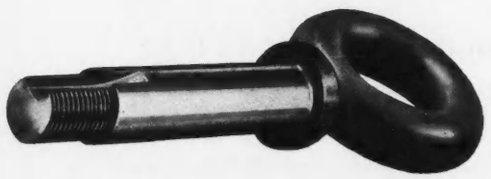

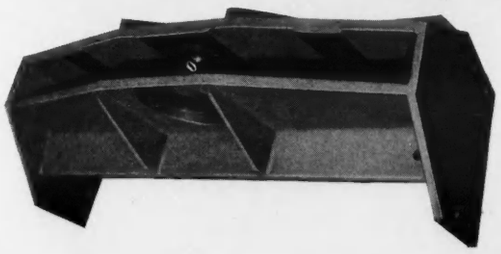

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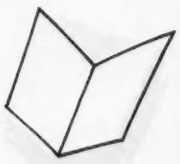

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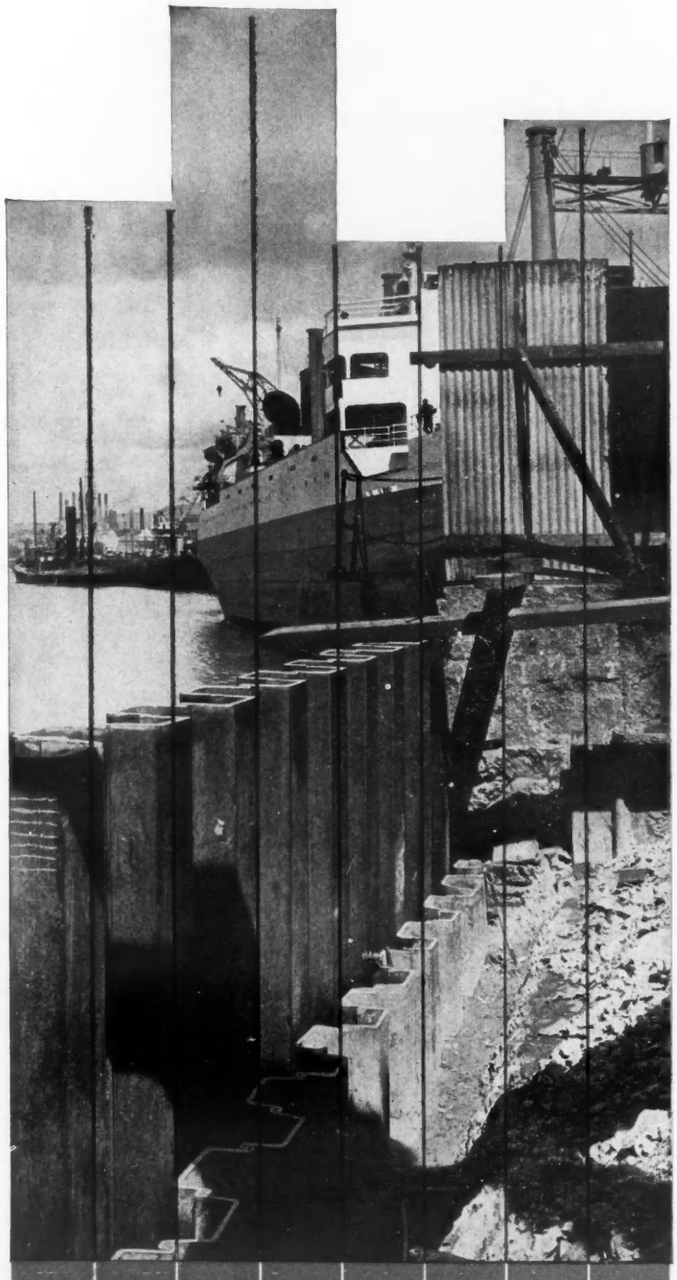

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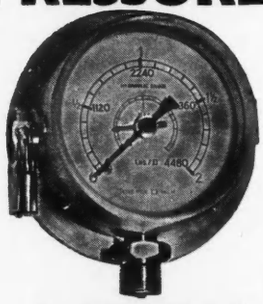

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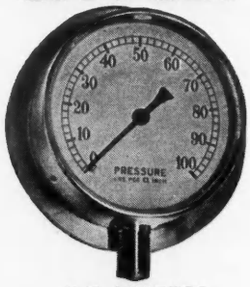


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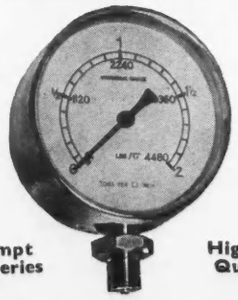

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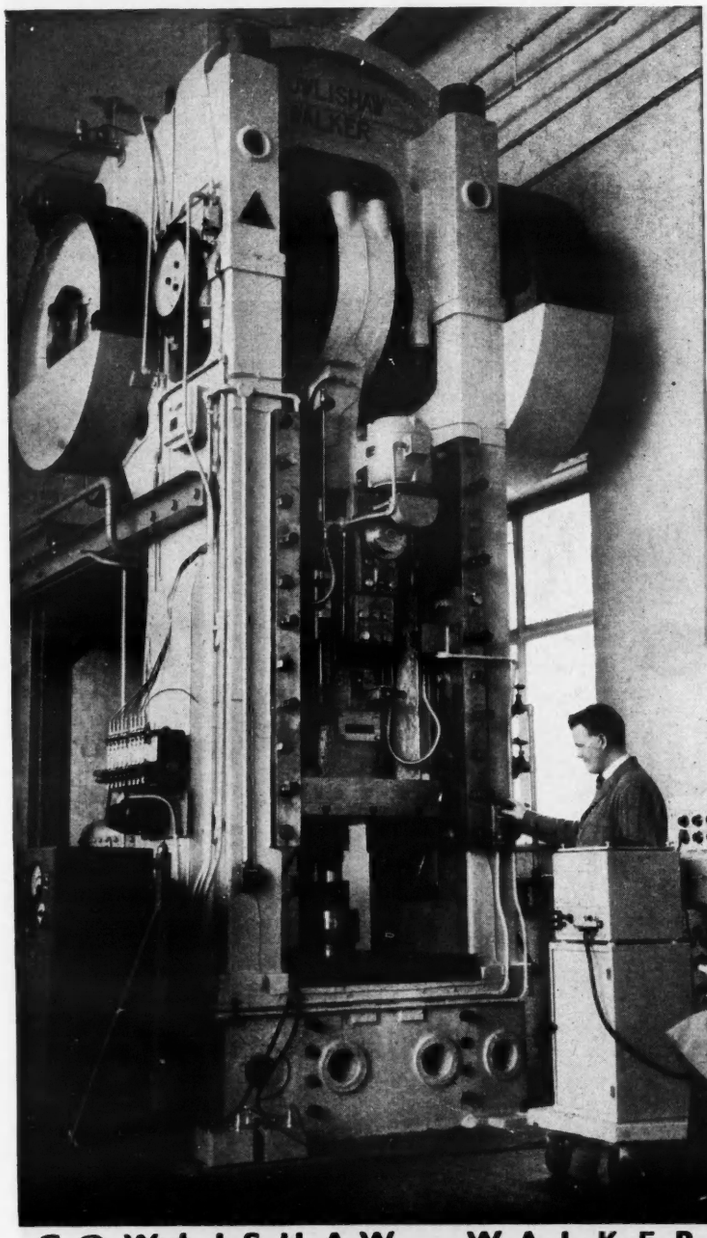

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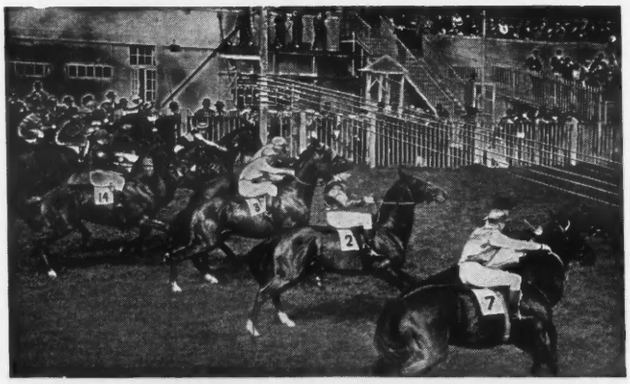
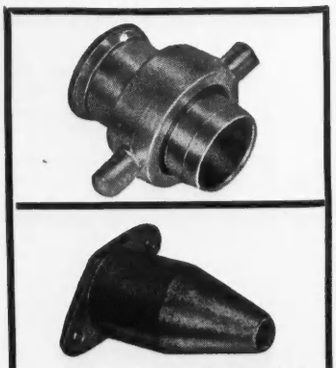


# The choice is often difficult



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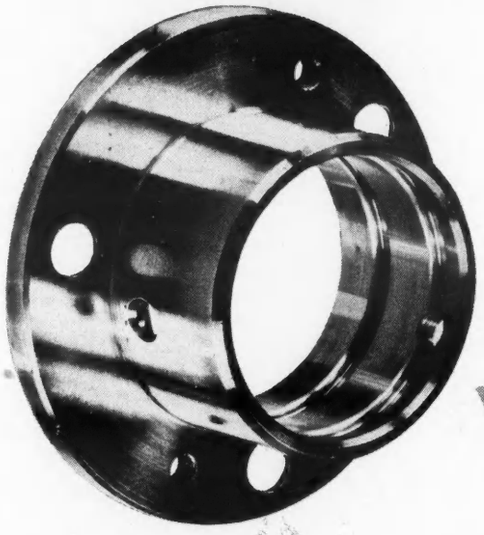

# Turbocharger plain bearing?

This is a photograph of a turbocharger plain bearing taken after many thousands of running hours, its condition is almost

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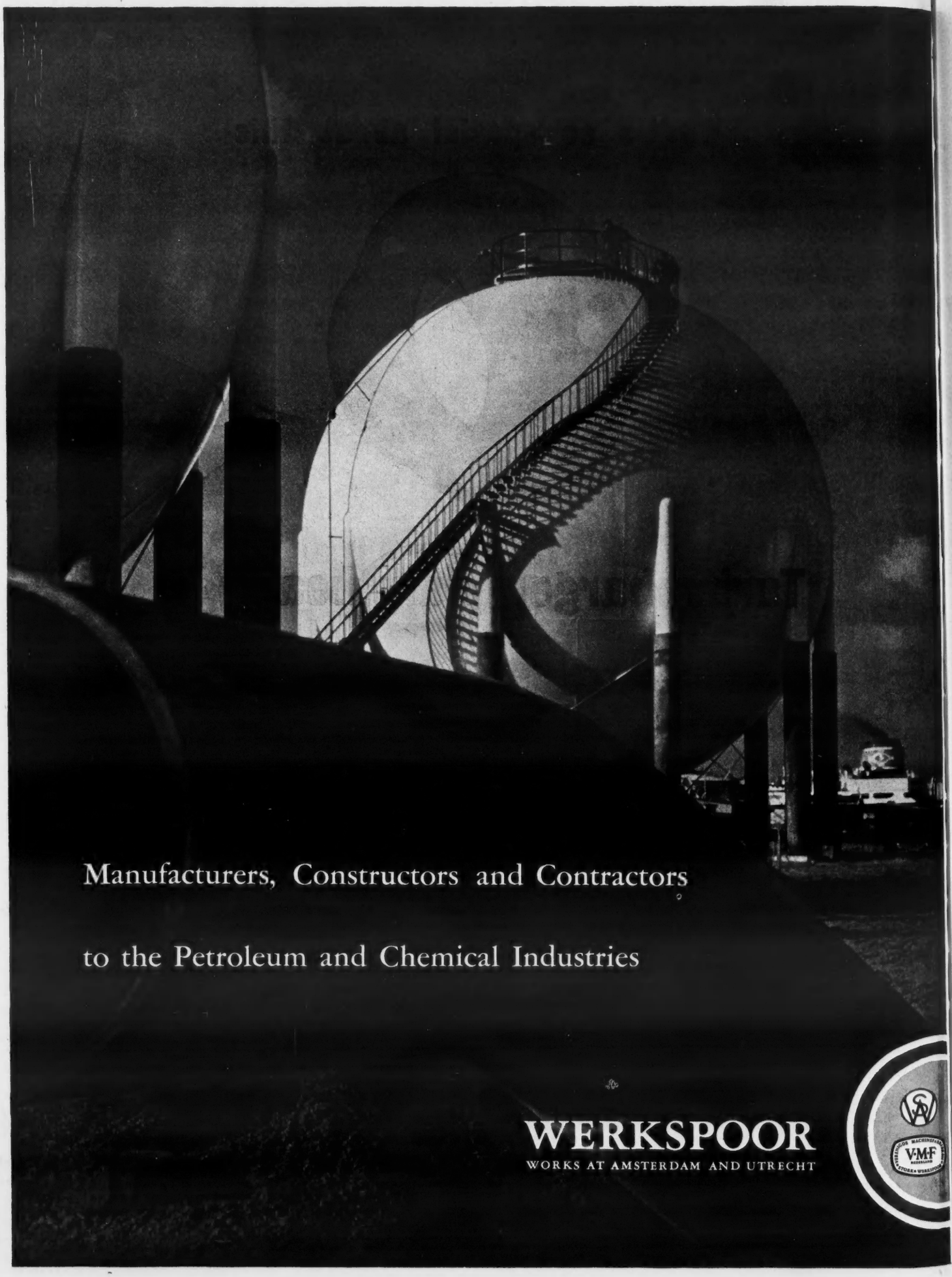
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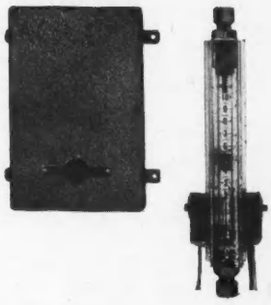
# FLOW CONTROL with the FLO-SCAN

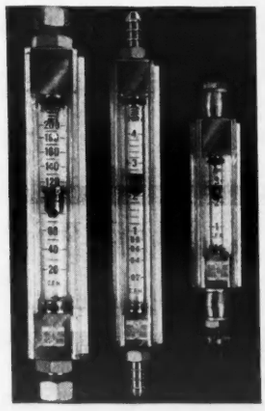


This is a flow operated alarm switch for the Gapmeter direct-indicating flowmeter.

A small lamp housing and a photo transistor are located on opposite sides of the Gapmeter tube, and the alarm is operated when the indicator float of the Gapmeter interrupts the light beam : this ensures failure to safety.

The Flo-scan signals a change in the rate of flow of any gas or transparent liquid, and can be used to control lamps, bells or relay circuits. Two sets of contacts allow 'normal' and 'alarm' circuits to be operated.

A single Gapmeter can be fitted with two Flo-scans to provide warning of both high and low flow deviations. The Flo-scan is readily adjustable and can be fitted to Gapmeters already in use. The weatherproof Switch Box can be mounted remotely.



The GAPMETERS are compact direct-indicating variable-area flowmeters with bold scales. They are made for ¼" ½" and ¾" B.S.P. sizes (Nozzle, Straight Union or Banjo fittings — interchangeable for Front or Back of Panel pipe connections.

Flow Range : 0.1—200 c.f.h. air ; 0.5—60 g.p.h. water. Price Range : £2. 15. 0d. — £4. 2. 0d. Gapmeters are made in materials for all industrial fluids and are protected by Perspex covers. These flowmeters are used for Service Fluids, Fuels, Scavenging Fluids, Cooling Fluids, Inert Gases, etc.

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*Engaged in the British Railways electrification programme: one of a fleet of 40 ft. Platforms owned by B.I.C.C.*

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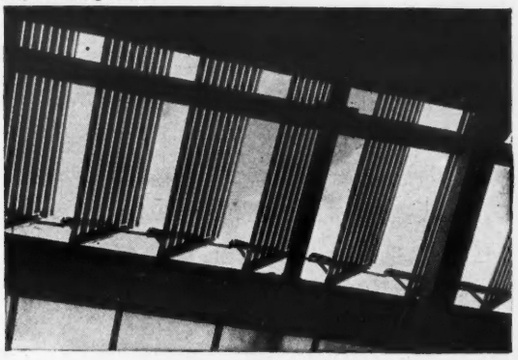

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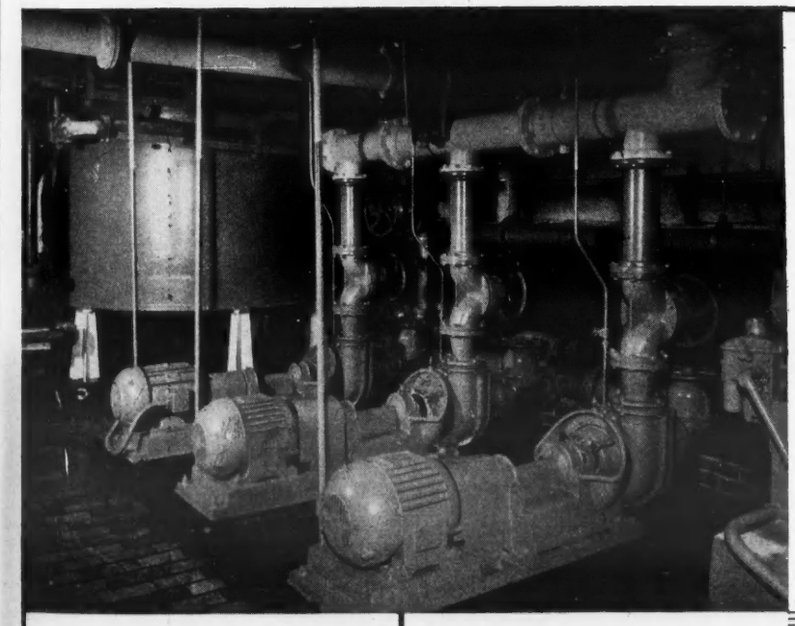

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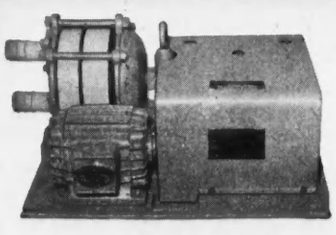
*(Bottom left) Close-up view of diaphragm pump similar to the hand operated unit but arranged for motor drive*
*(Bottom centre) Hand operated portable diaphragm pump for emptying carboys or tanks and for general duties.*
*(Bottom right) Portable rotary displacement pump pumping plating solutions in the motor car trade*



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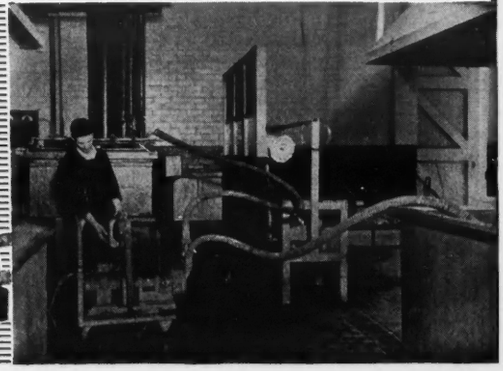

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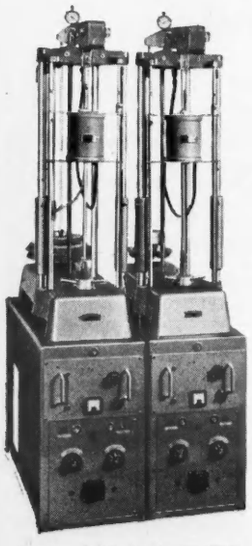

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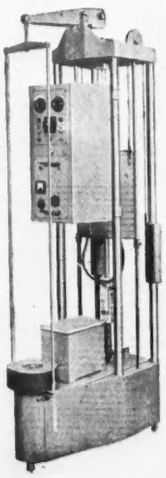

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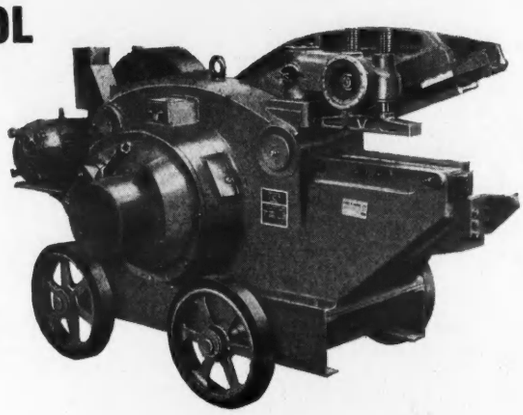

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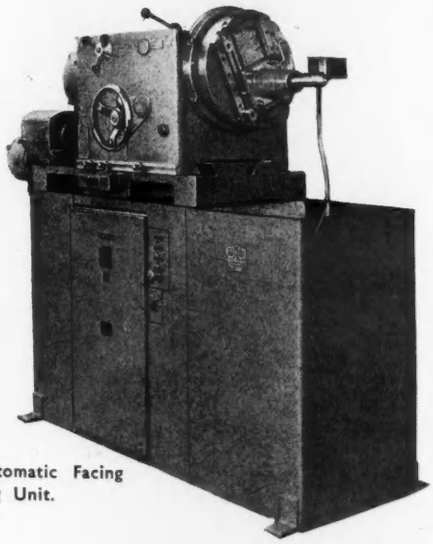
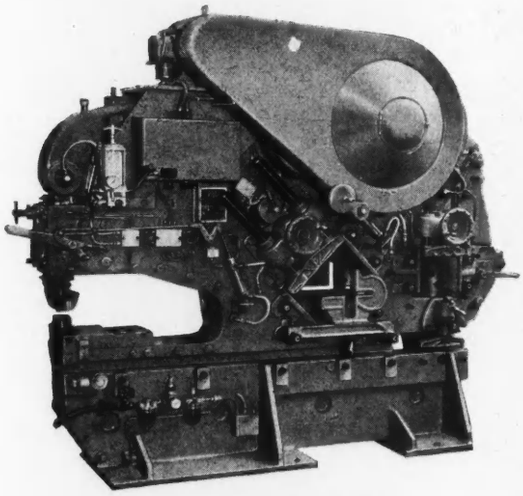
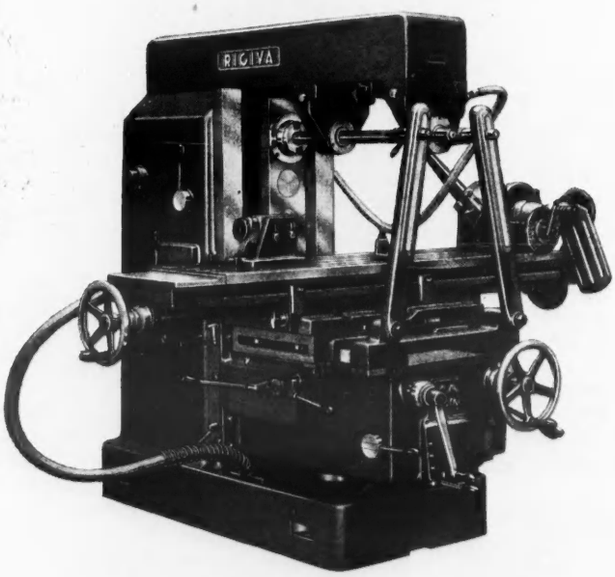


B.Y.C. Automatic Facing and Boring Unit.



'FICEP' Universal Punching, Shearing, Cropping and Notching Machines.

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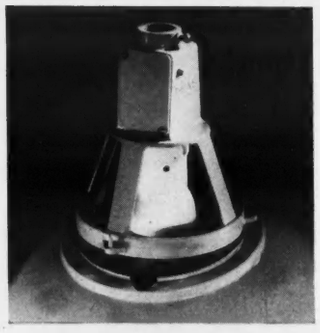

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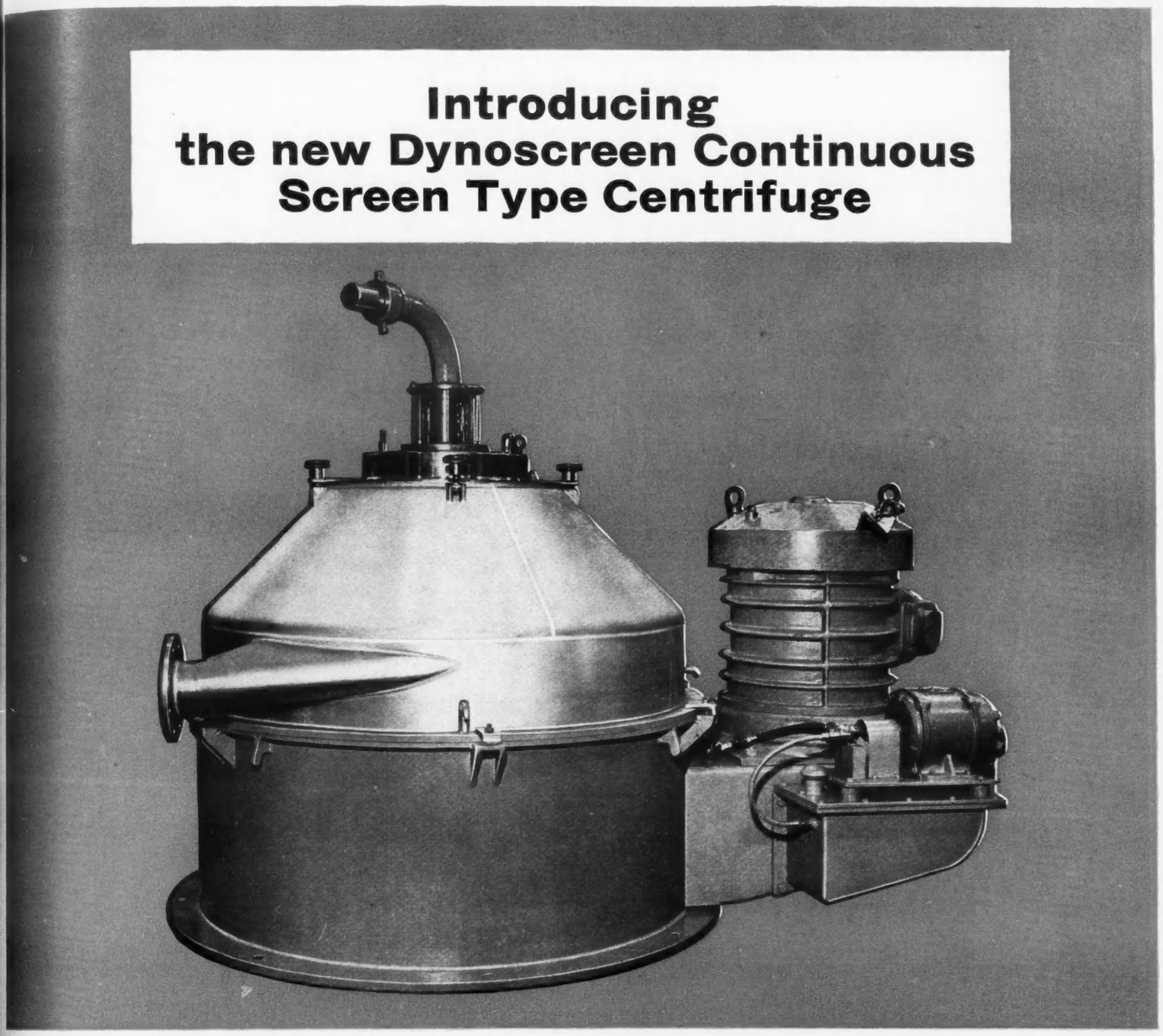

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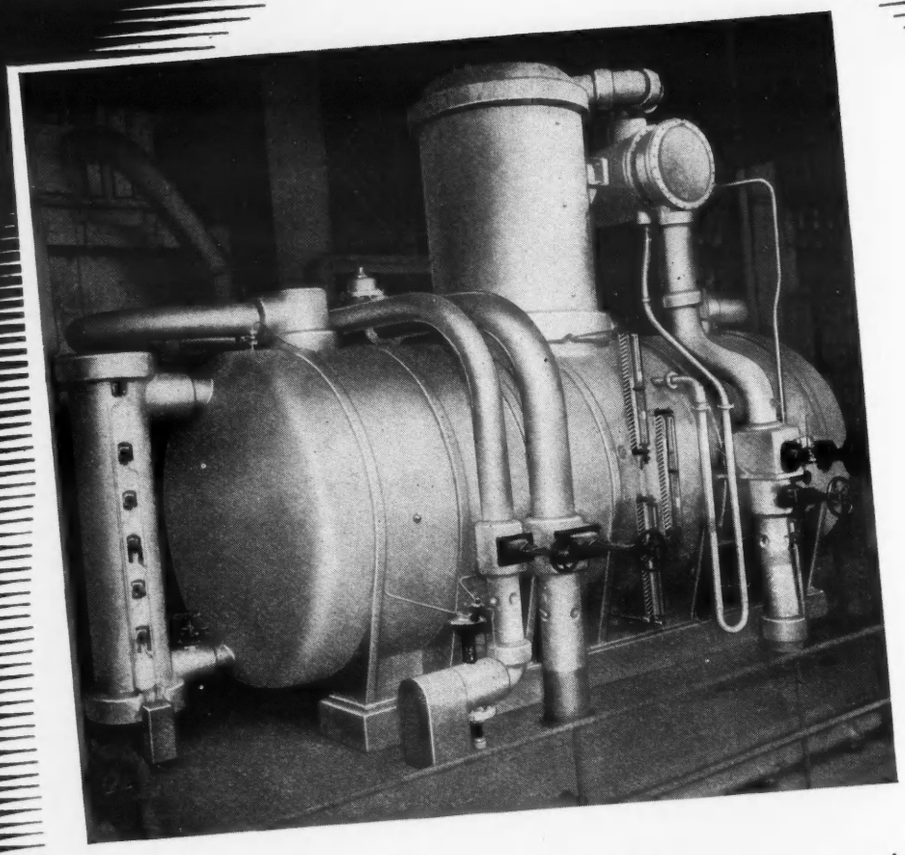

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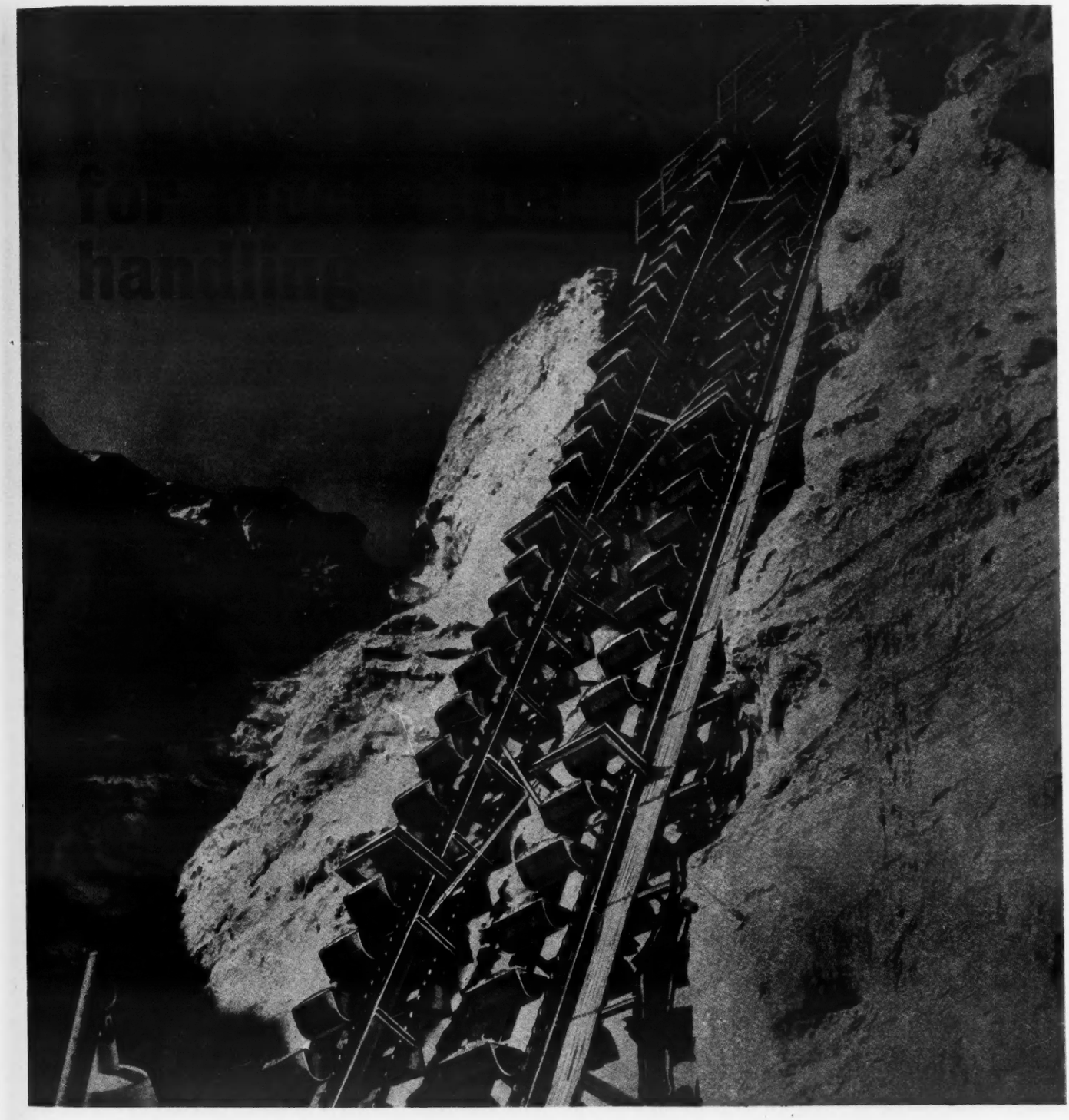

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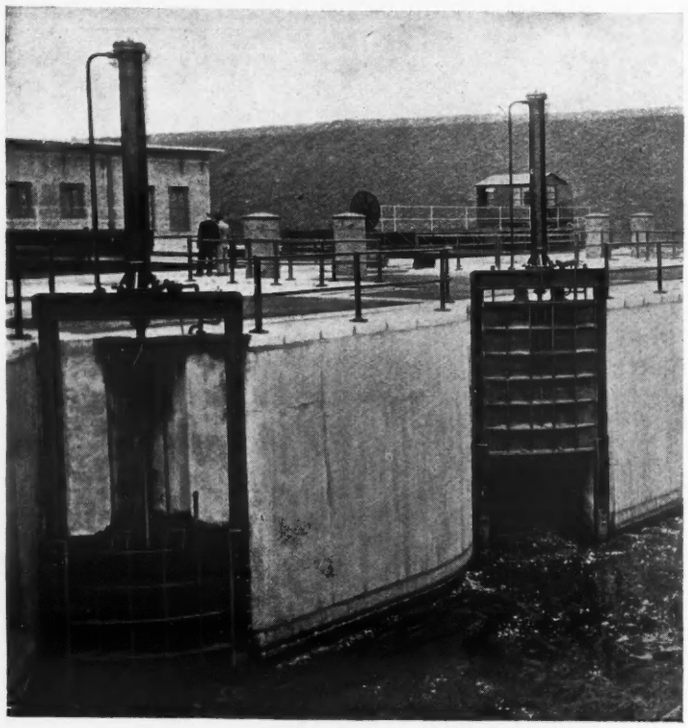

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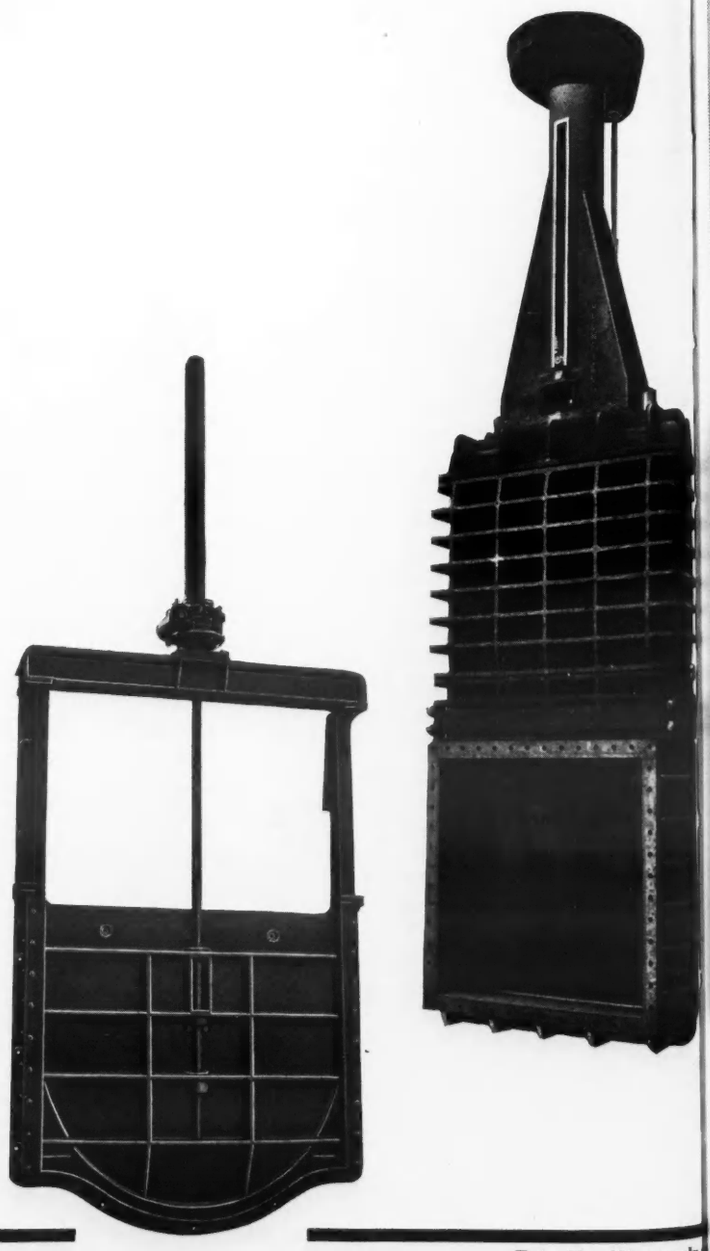
**Two styles are available, an orthodox pattern for wall-mounting or installation in open waterways and a dry-well version for culverts, both robustly constructed MEEHANITE iron with bronze trim.**

**Illustrated are hydraulically driven units in a sewage purification works, and examples of hand operated wall-mounting and electrically actuated dry-well types.**



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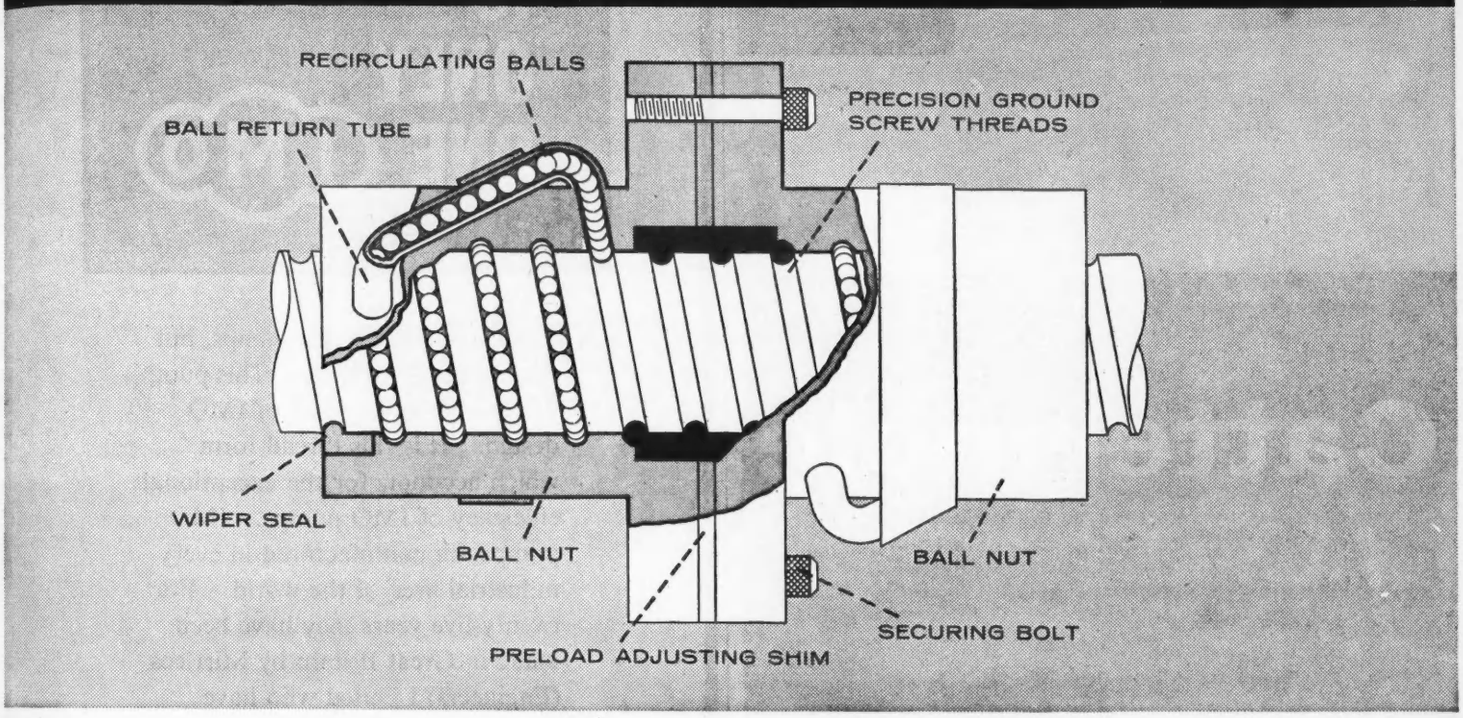
# Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...

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Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of —52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

### Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

**Bristol Siddeley Beaver ball splines** have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

*For further information please write to:*
J. B. STARKY, SALES MANAGER (BEAVER PRODUCTS DIVISION), BRISTOL SIDDELEY ENGINES LIMITED, PO BOX 17, COVENTRY, ENGLAND.

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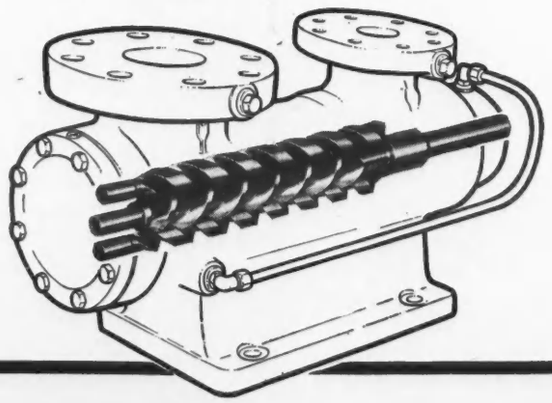

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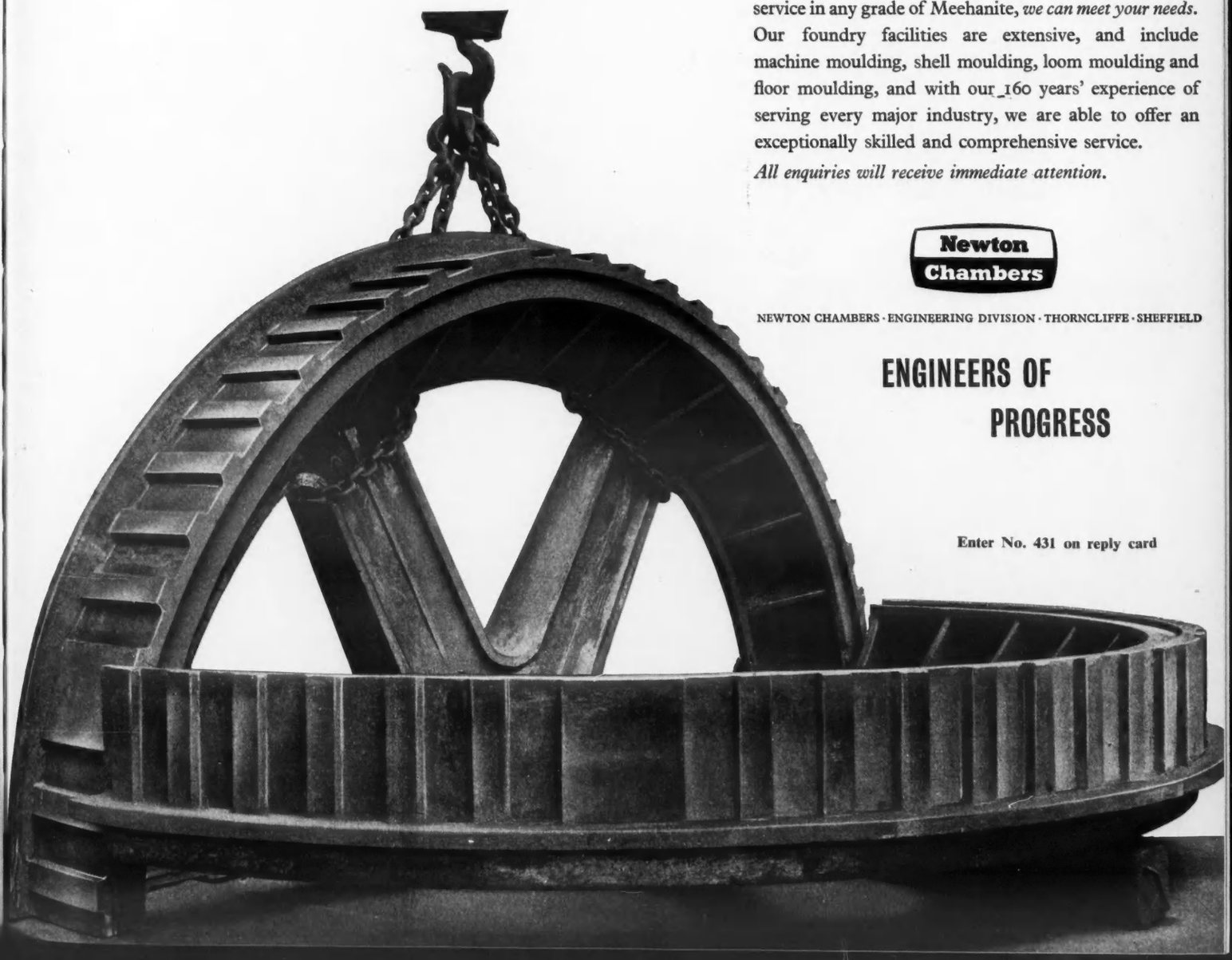

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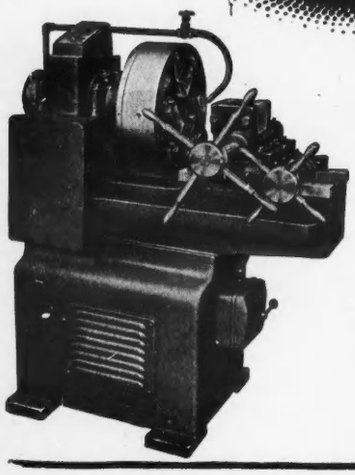

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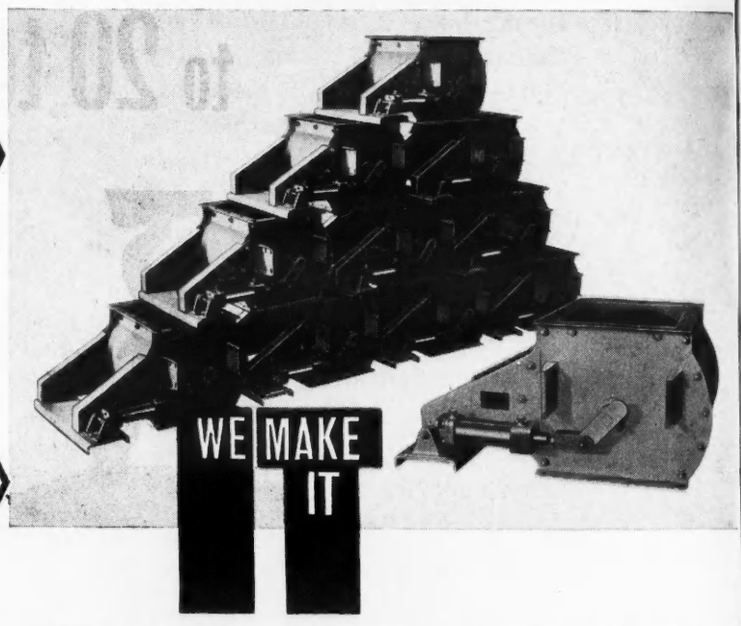


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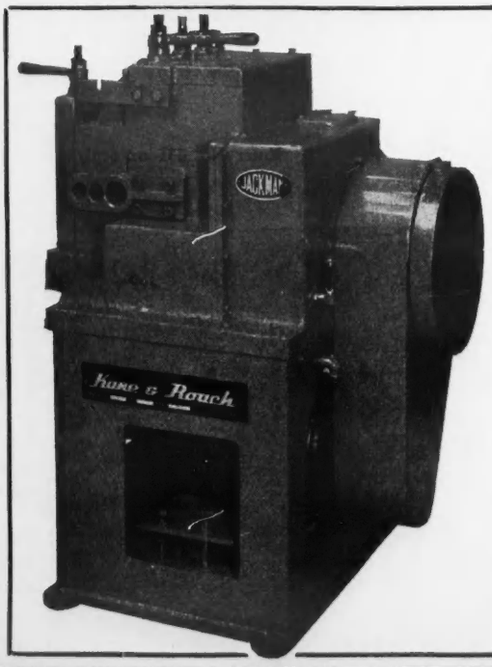


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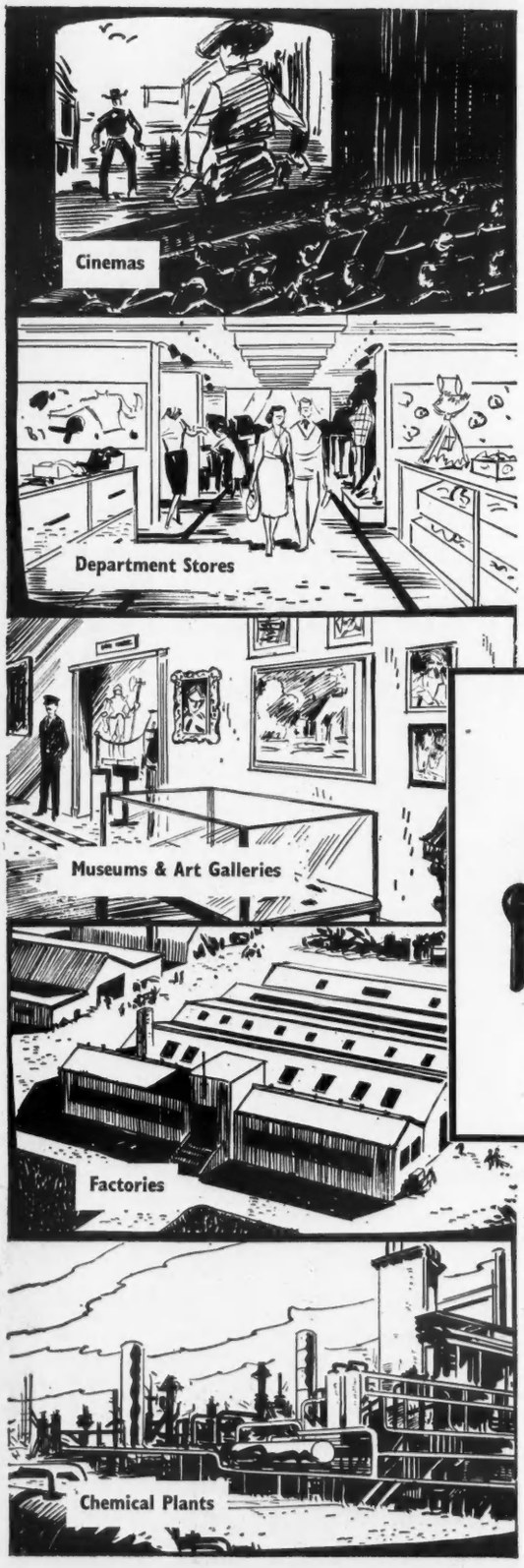
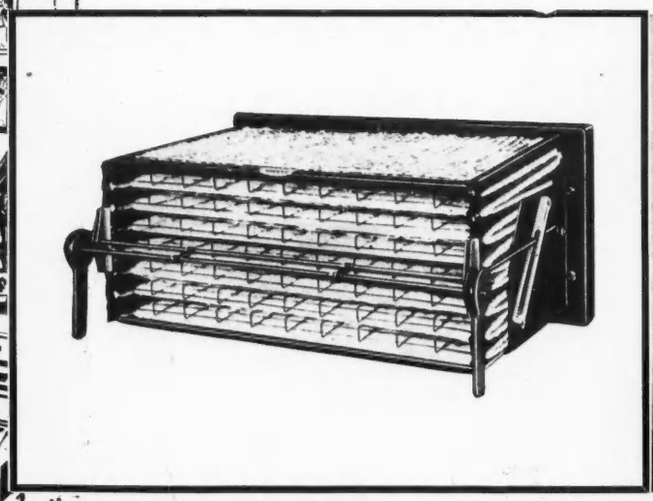
# TRUST* K.600 KOMPAKS to clear the air

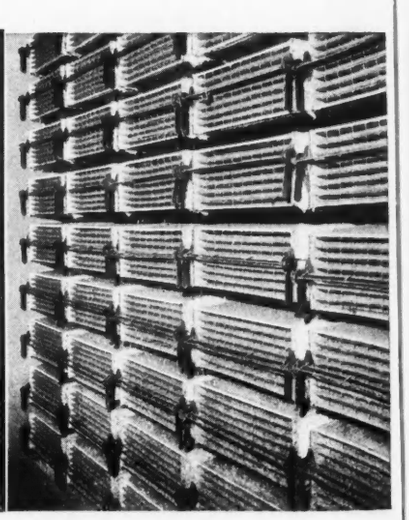



Perfected by years of research and development in the Vokes laboratories and in the field, the K.600 'Kompak' air conditioning filter is the most efficient as well as the most widely used of its type. Features which have led to its popularity include long life, reliability and extreme ease of maintenance.

Efficient air conditioning filters are essential in the provision of clean air inside buildings of all kinds. Impurities in the air supplied to factories can cause contamination of products or damage to valuable plant; in public buildings unfiltered air shortens the life of furnishings and decorations. Vokes K.600 'Kompaks' are installed in the air conditioning systems of large commercial and industrial office blocks, factories and engine test houses, public libraries and picture galleries, hotels and cinemas, concert halls, hospitals, multiple stores and establishments for scientific, pharmaceutical and photographic research and processing.

*** You can trust the K.600 'Kompak' because like all Vokes air filters it is fully tested in accordance with BSS.2831.**





Simply constructed and using an inexpensive, easily replaced filter medium, the K.600 'Kompak' has a normal rating of 600 cubic feet per minute with an initial resistance of 0.15 inches w.g. The actual velocity of the air passing through the developed area of the filter is only 22.5 feet per minute. Tested in accordance with BSS.2831, using highly penetrating test dusts, the 'Kompak' recorded an efficiency of 95% against Aloxite 50, and 93% against Aloxite 225.

The K.600 'Kompak' is ideal for general air conditioning, general ventilation and industrial air cleaning, particularly in areas where a sooty atmosphere prevails. It can also be supplied in flameproof and tropicalized versions, and a special super-efficiency type is available in which a layer of glass-wool backing the standard filter medium extends performance down to sub-micronic particles.

**'KOMPAKS' FOR KELVINATOR**

Kelvinator (Australia), who manufacture refrigerators for domestic and industrial purposes, use K.600 'Kompaks' as a second stage filter in their paint shop. The standard of paint finish acceptable is extremely high and efficient filtration of the dusty air is essential, particularly as the high gloss paint used accentuates any dirt defects. Since their installation the two banks of seventy filters each have given complete satisfaction, one bank having been in operation for two years without replacement of the filter medium. The intake (dirty) side of one bank is shown in the photograph above.

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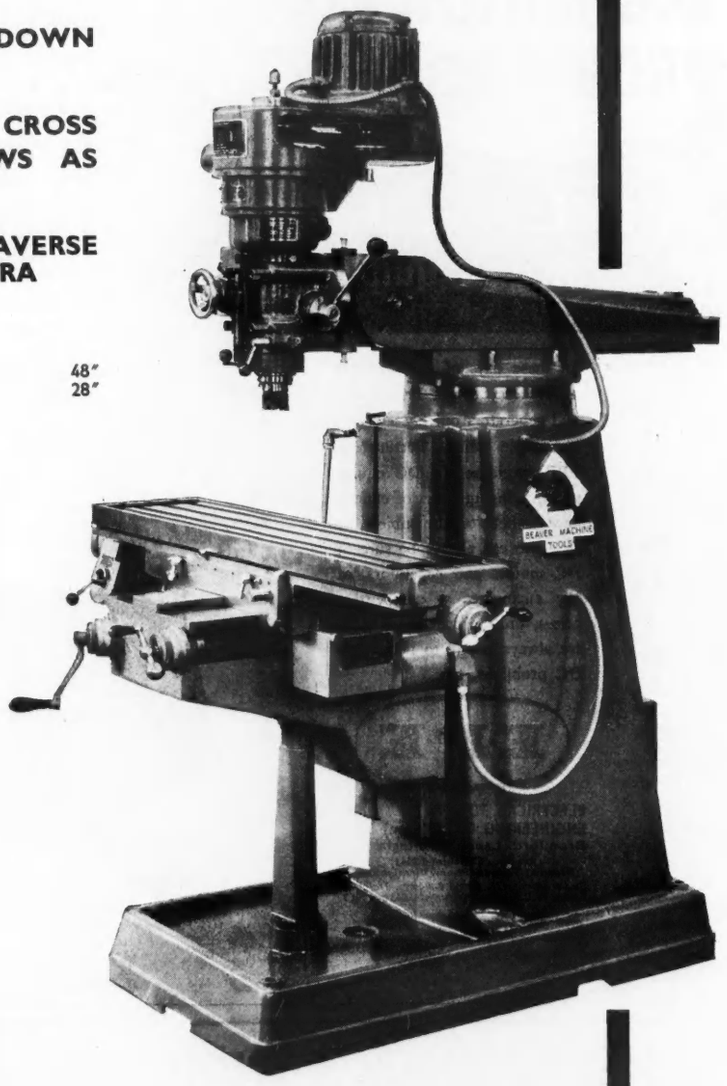

## RANGE

| | | | | |
|---|---|---|---|---|
| Table length | 32″ | 36″ | 44″ | 48″ |
| Longitudinal Feed | 12″ | 16″ | 24″ | 28″ |
| Width of Table | 10″ | | | |

All with power feed

T slots 3 at 11/16″ x 2½″ crs.
Longitudinal Power Feed table only.
L.H. or R.H. ½″–4½″ or 1″–9″ per min.
Cross table traverse 12″
Vertical table traverse 19″

## SPINDLE MOTOR

1, 1½″ or 2 h.p. recommended at 1500 R.P.M.
Voltages to suit customers' requirements.

## SPINDLE

Spindle nose No. 30 IST.
Spindle Speeds No. 8
Spindle Speeds range 80 to 3000 R.P.M.
Spindle quill traverse 5″
Spindle centre line turns through 180 deg. (in longitudinal plane and 90 deg. in transverse plane).
Spindle power feed ·0015″–·003″ & ·006″ per rev.

**NETT WEIGHT** 19 cwt. 970 kg.

| | |
|---|---|
| Overarm adjustment from column face, maximum | 22″ |
| Overarm adjustment from column face, minimum | 5½″ |
| Spindle nose to top of table, maximum | 19″ |
| Spindle nose to top of table, minimum | 0″ |
| Face of column to centre line of T slot in table, maximum | 17″ |
| Face of column to centre line of T slot in table, minimum | 5″ |

Illustrations and specifications not binding as to detail.

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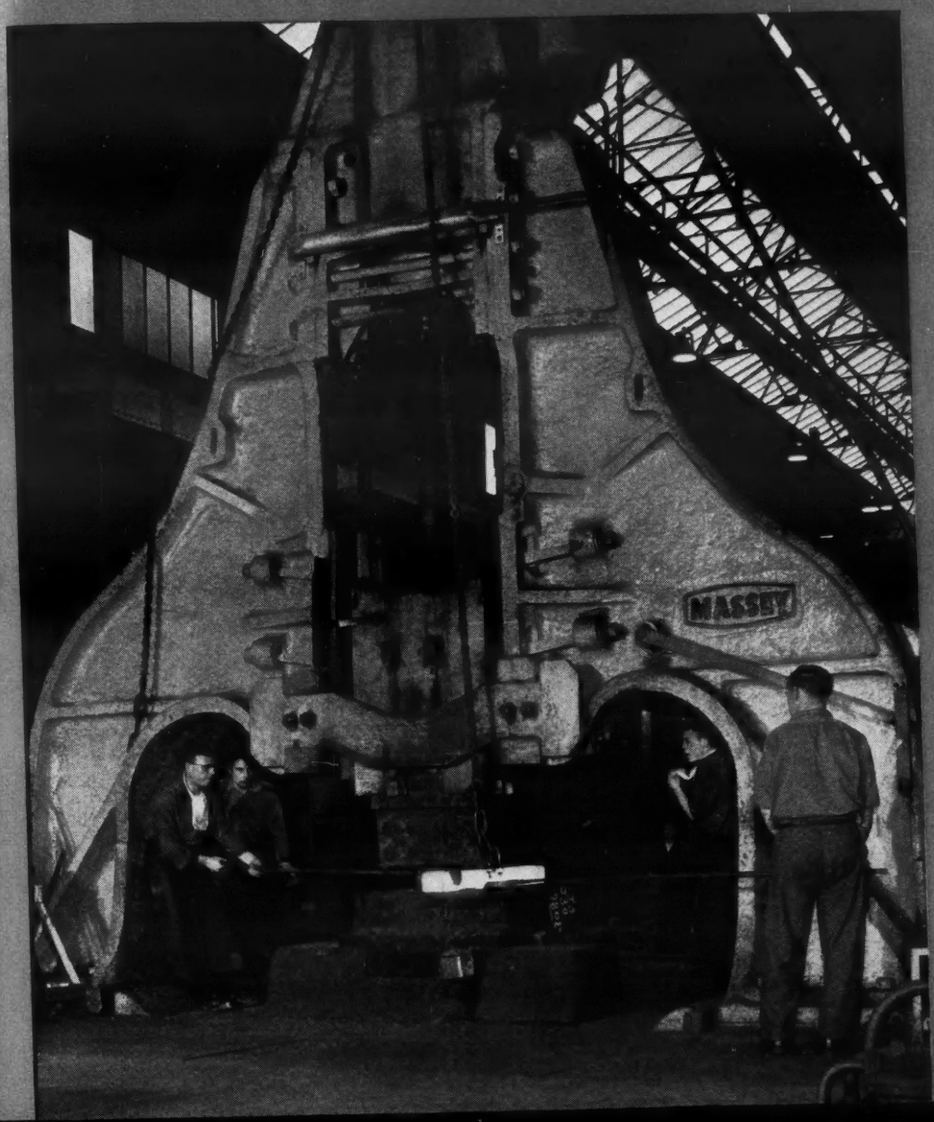


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*Carpet mountings are fitted under the 4-ton Massey hammer in the photograph, reproduced by courtesy of Jessop-Saville Ltd., Sheffield. Contractors for the foundation: Wellerman Bros. Ltd., Sheffield.*

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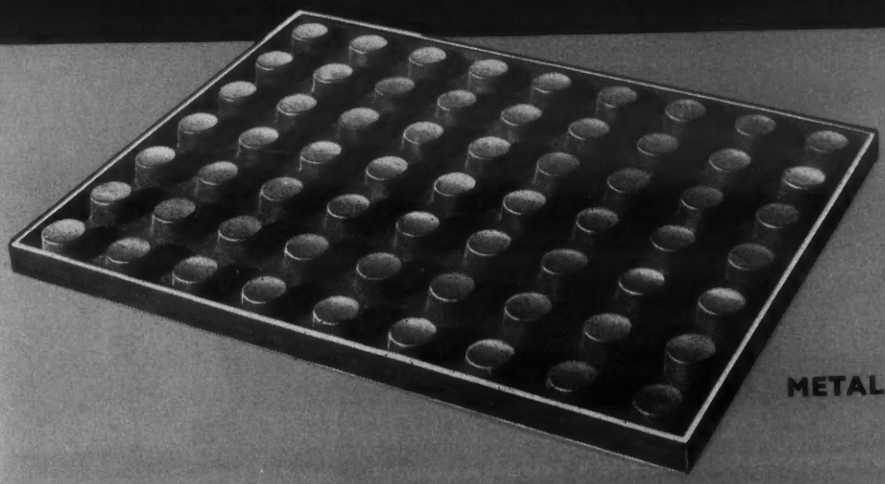

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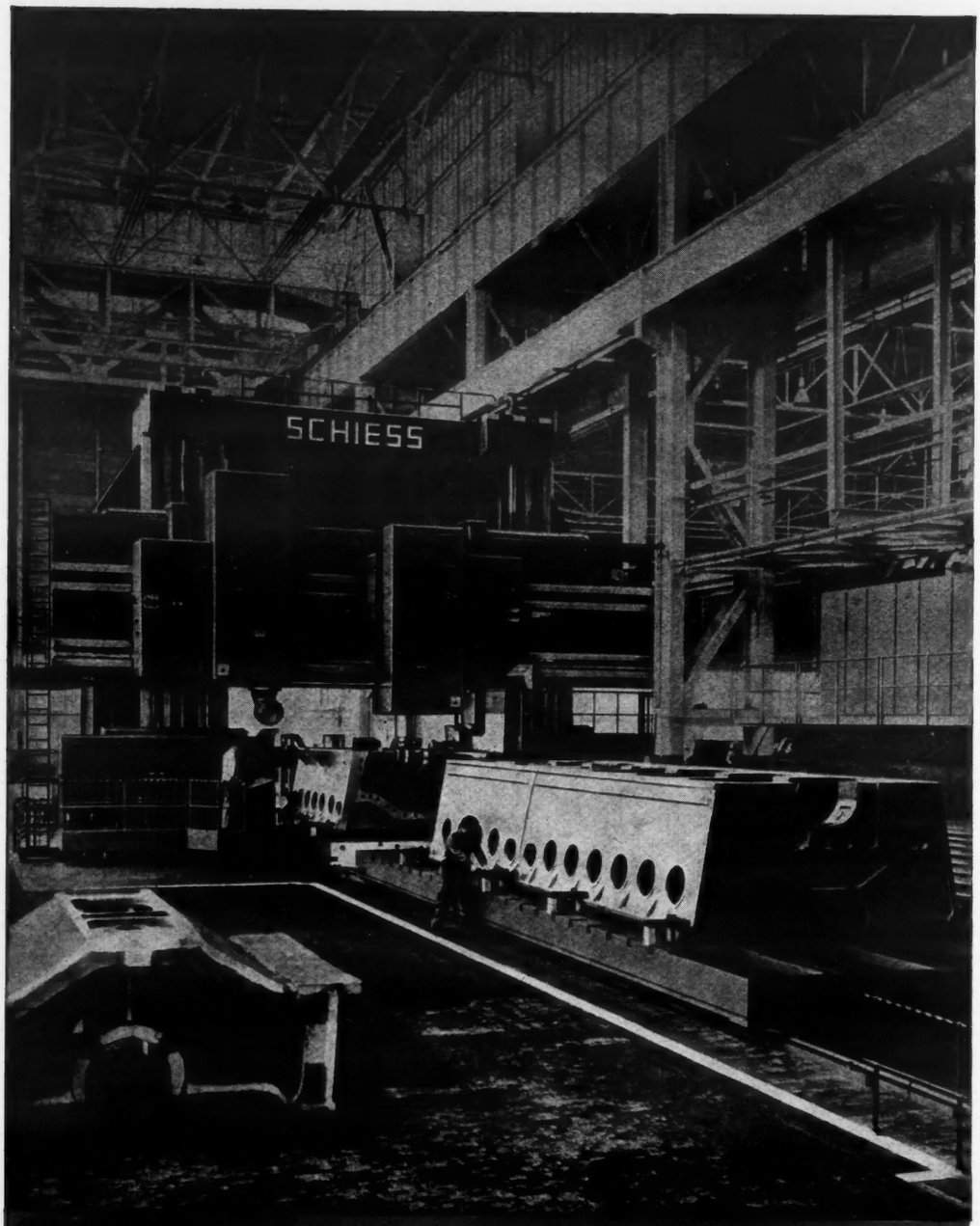


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machining a large diesel engine component in the new workshops of Messrs. Gebr. Sulzer AG., Oberwintershur (Switzerland)

| Technical data : | |
|---|---|
| Daylight | 14' 9" x 14' 9" |
| Bed Length | 150' |
| Milling Length | 65' |
| Height of Machine | 46' |
| Length of Cross Rail | 45' |
| Heaviest Workpiece | 150 tons |
| Installed Horsepower | 1500 |
| Total Weight of Machine | 900 tons |

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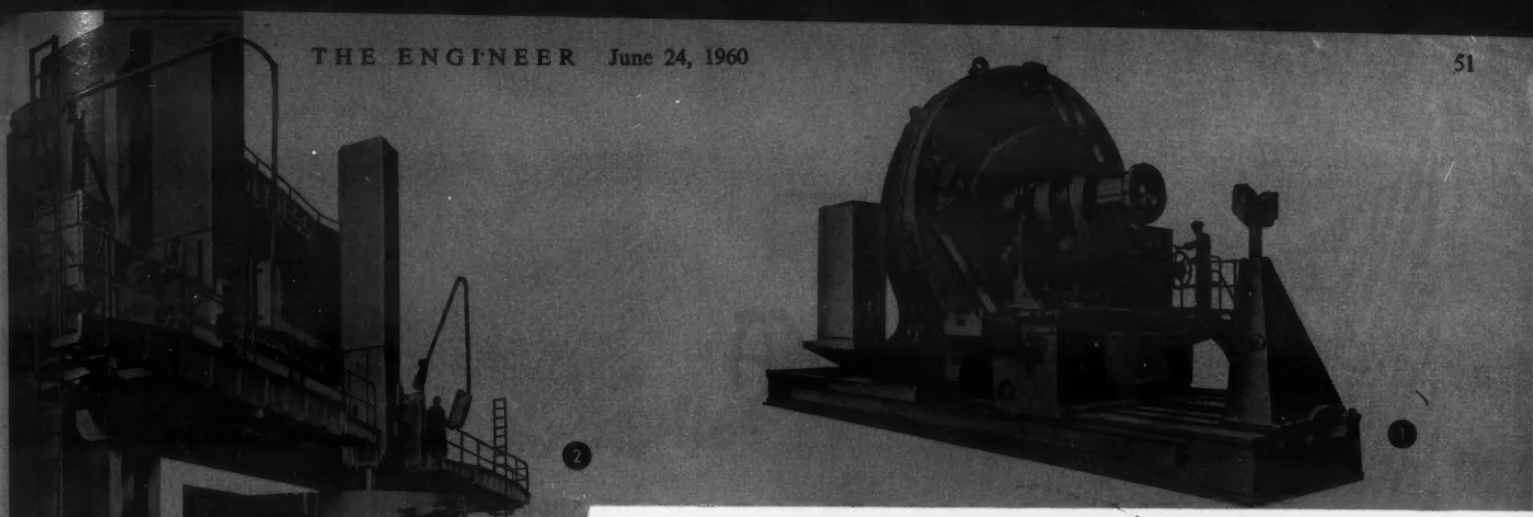

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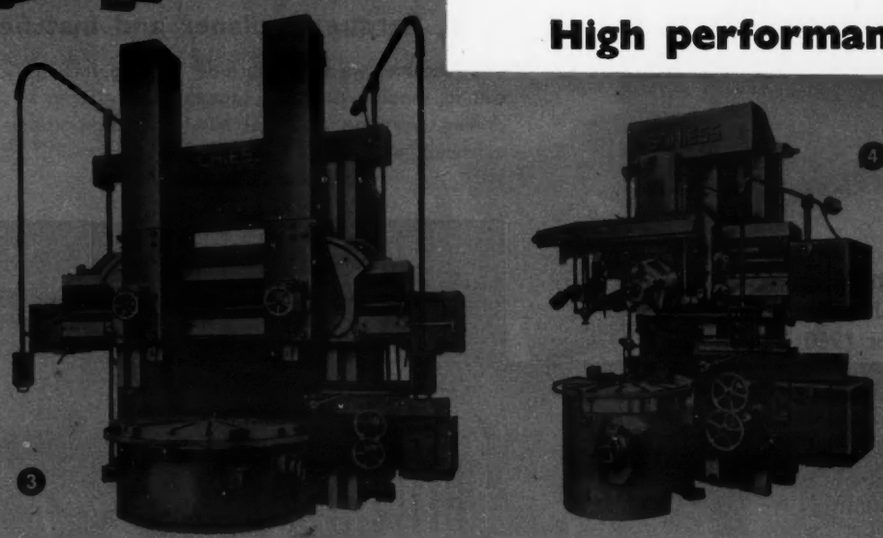



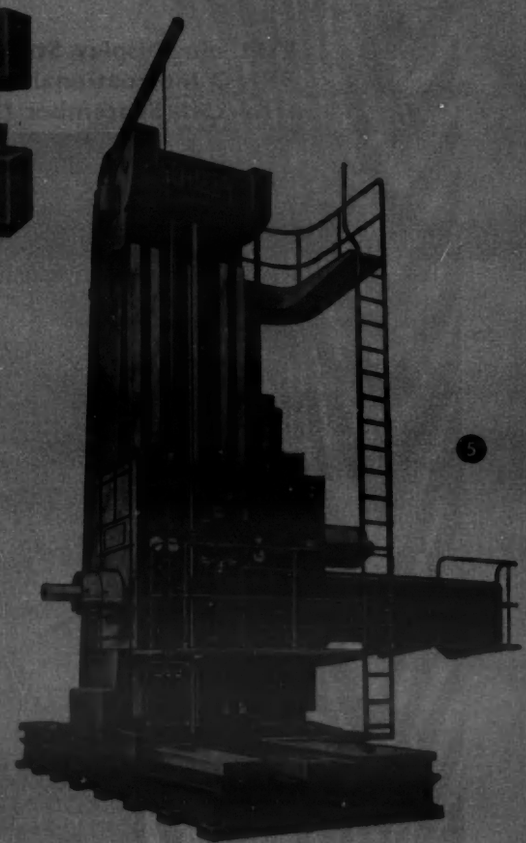

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2. Giant Vertical Boring Mill 26 GK 800/1000, with dual table. Maximum turning diameter 394in.
3. Double Column Vertical Boring Mill KZ 200. Maximum turning diameter 79in.
4. Single Column Vertical Turret Lathe KE 100, with copying device. Maximum turning diameter 39in.
5. Horizontal Milling and Boring Machine FB32/19, with 12⅝in. milling spindle and 7½in. boring spindle.
6. Precision Gear Hobbing Machine RF 40/60 S, shown with finish machined 157in. dia. marine turbine gear for transmitting 16,000 H.P.

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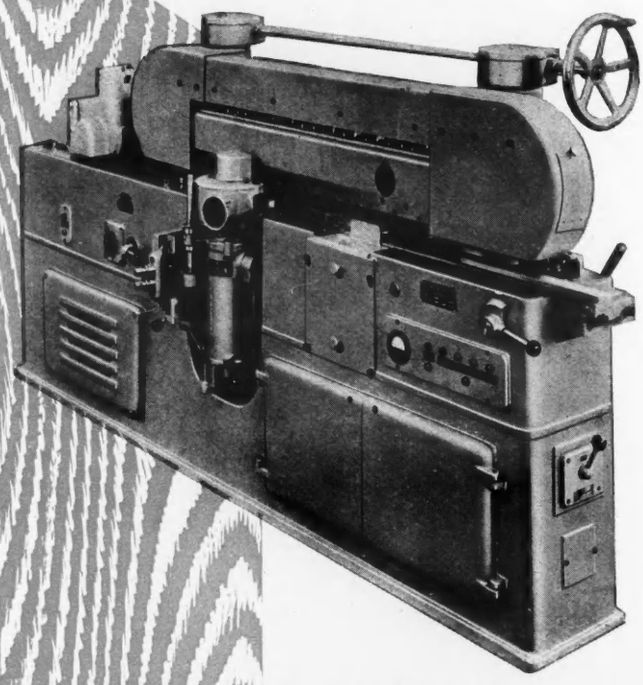

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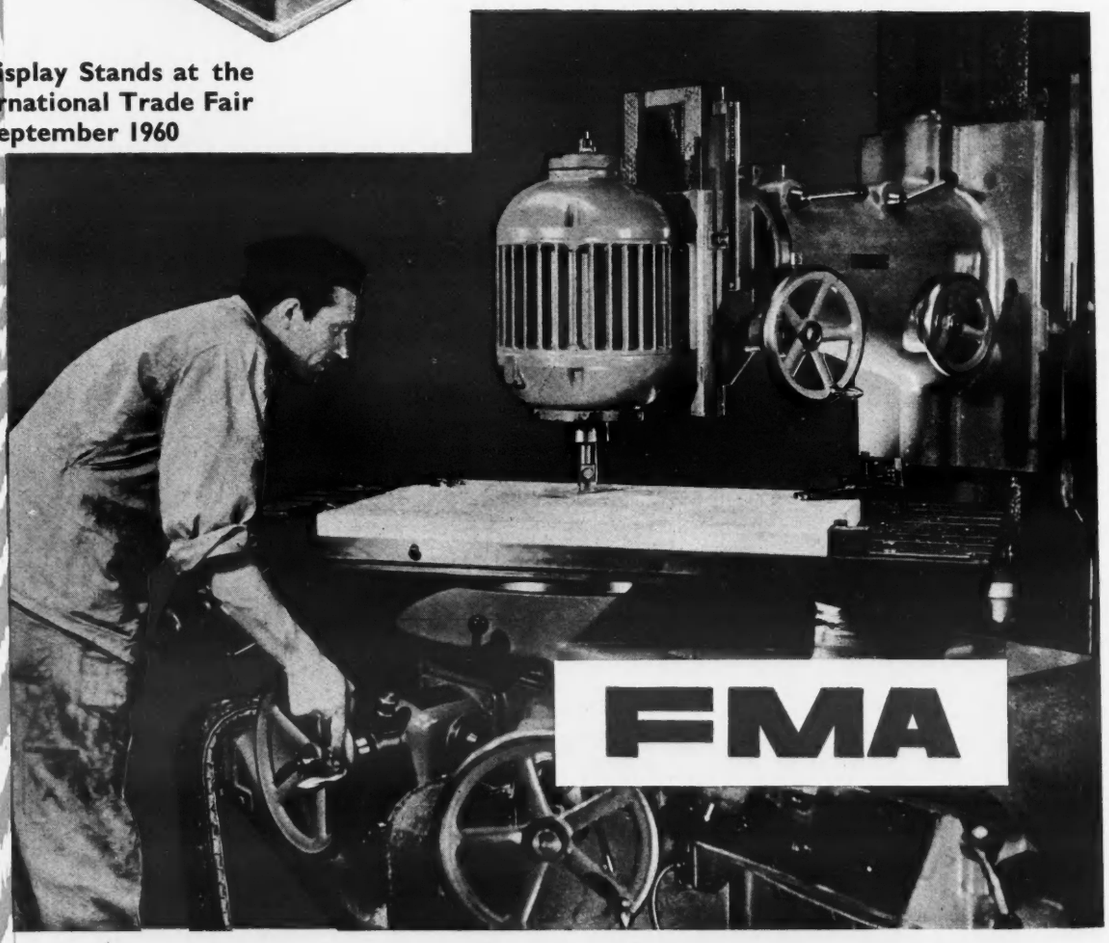

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is suitable for pattern shops and production of intricate shapes in wood

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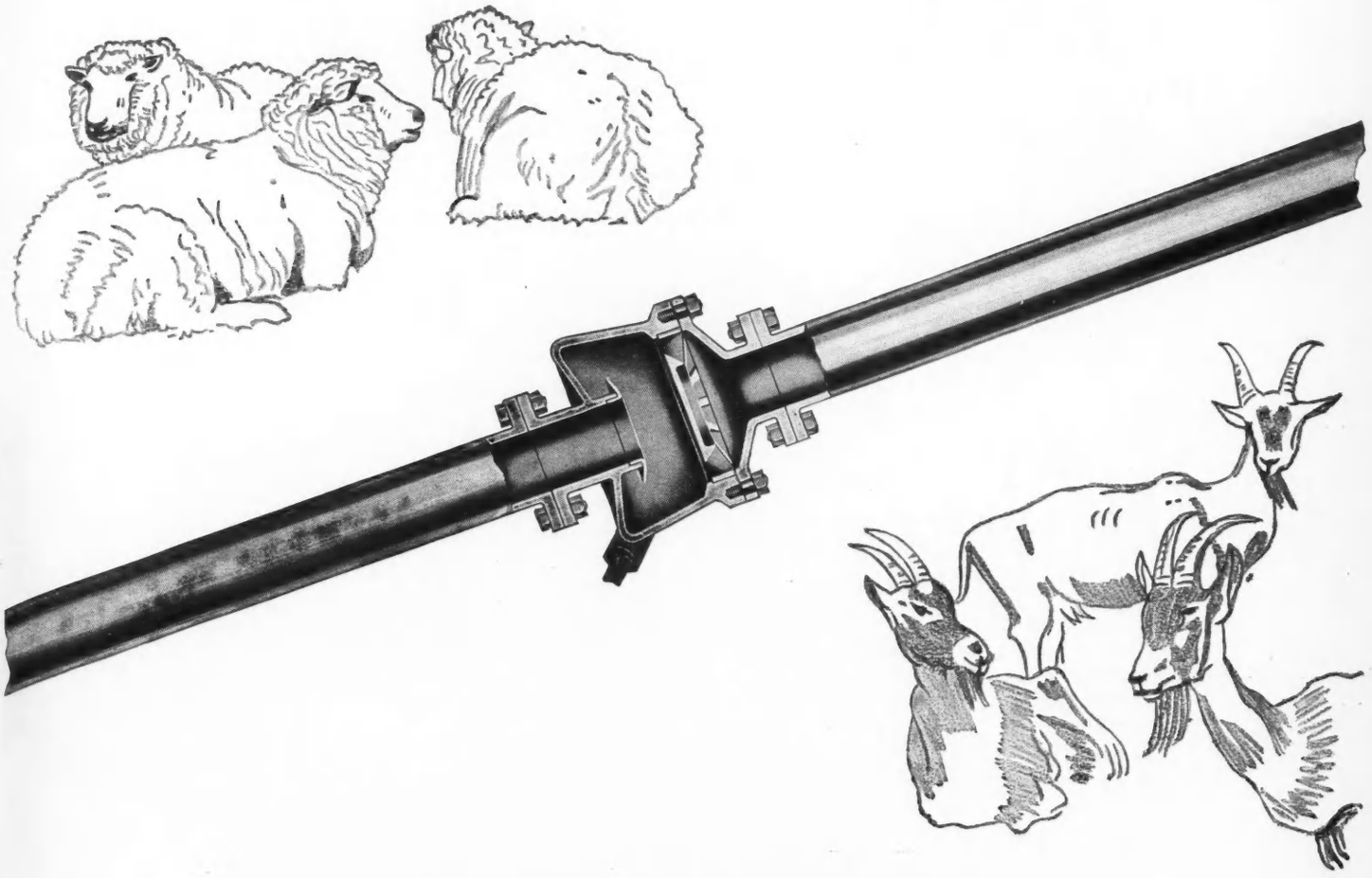
# Sheep and goats!
# Oil and Water!
## it's all a matter of separation



**We cannot deal with sheep or goats, but the 'Supreme Vortex' pipe line separator is unsurpassed for separating . . . .**

***Moisture*** **and oil drops from compressed air**
***Moisture*** **from steam**
***Dirt particles*** **from gases**

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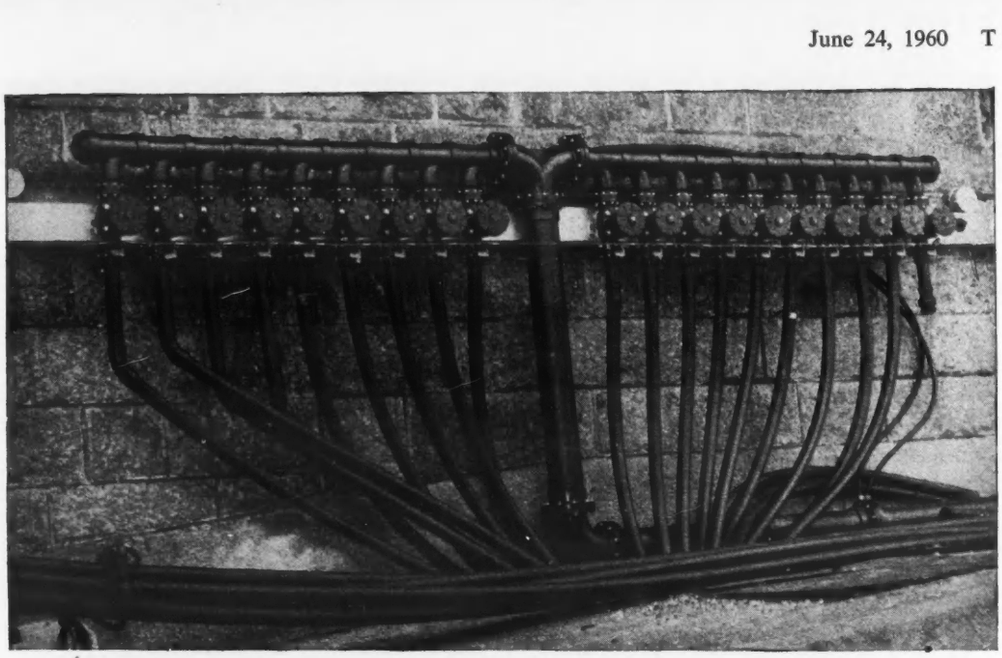
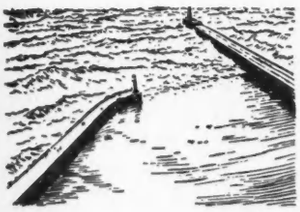


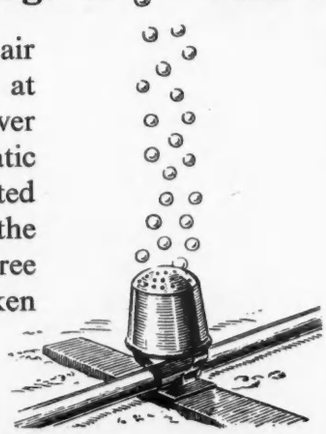
Saunders Valves with Vulcathene bodies, Marleythene Pipes and Vulcathene Manifold in the Pneumatic Breakwater

# Safety at Sea . . by Air

## Bubble barrage to calm harbour water

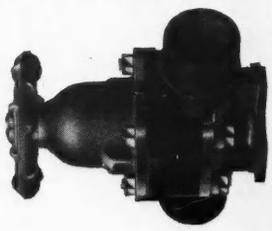


By their system of air bubble distribution at the entrance to Dover Harbour, Pneumatic Breakwaters Limited cleverly redirect the wave forces to a degree that enables berthing to be safely undertaken with rough weather prevailing.



Giant air bubbles, vented from two pipelines on the sea bed in this experiment are controlled by Saunders Diaphragm Valves arranged in the Vulcathene manifold illustrated above.

Such bubble blowing below demands leak-proof control at the valves.



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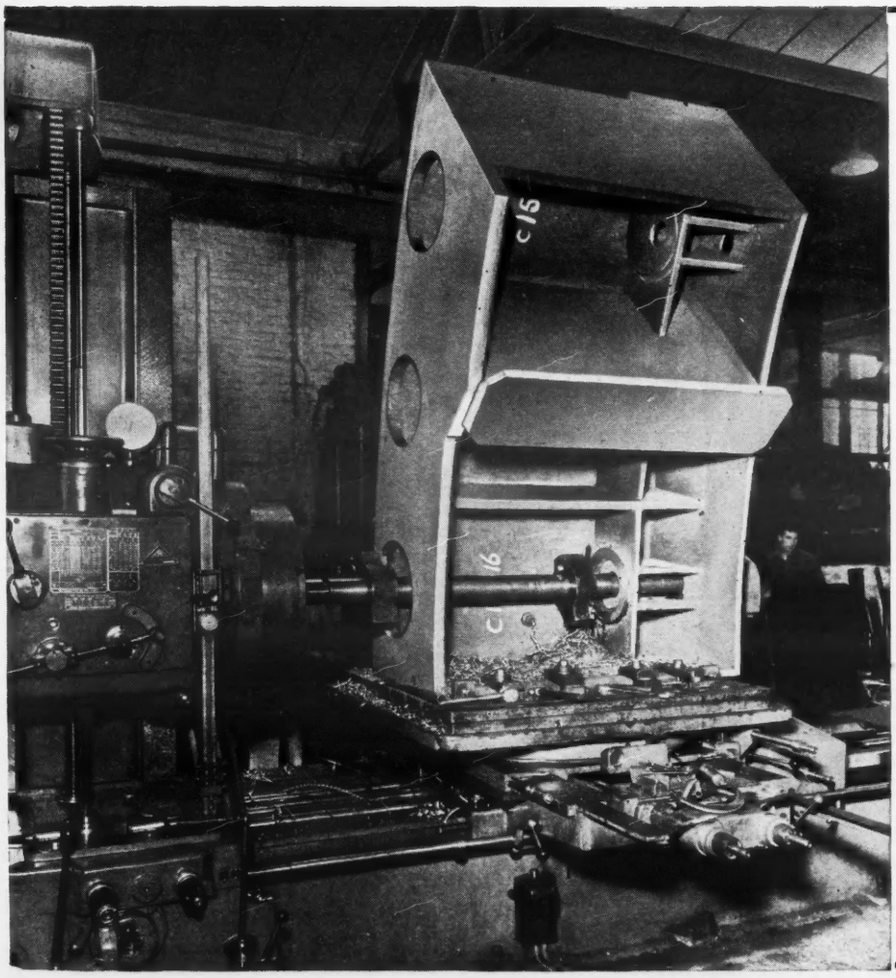

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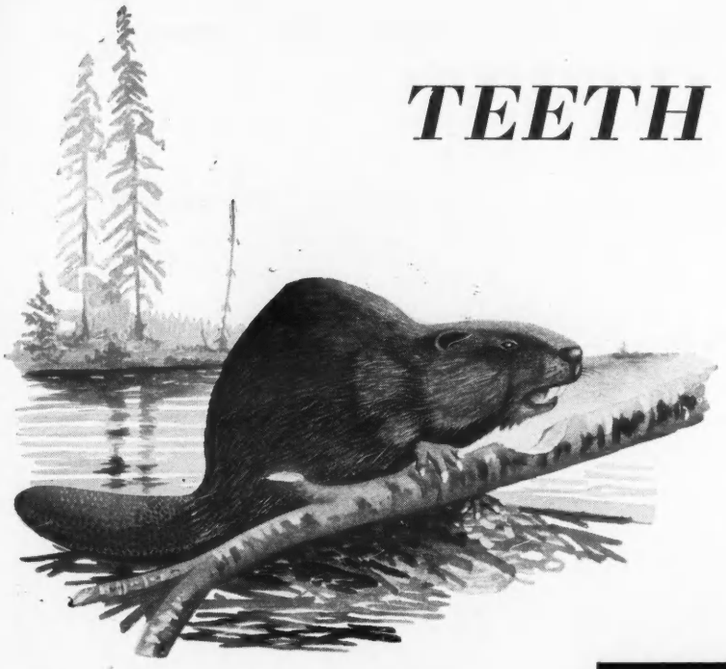

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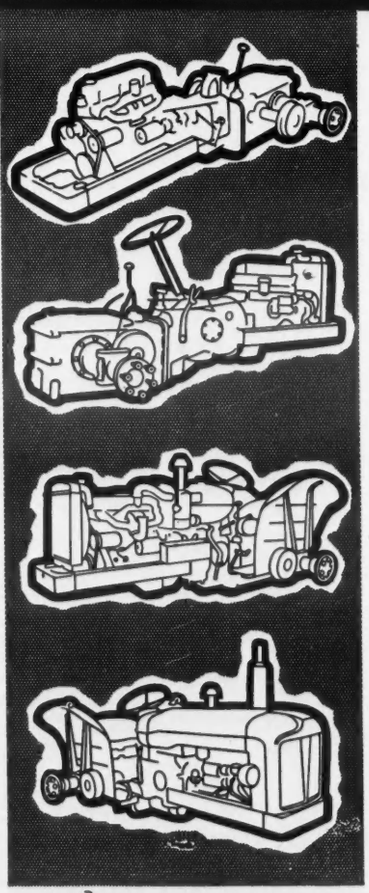

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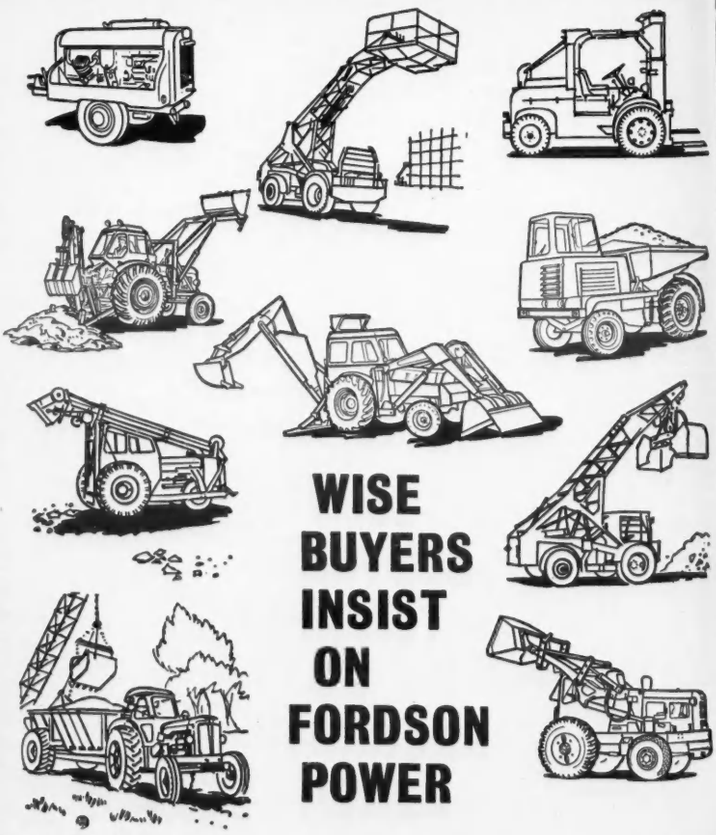

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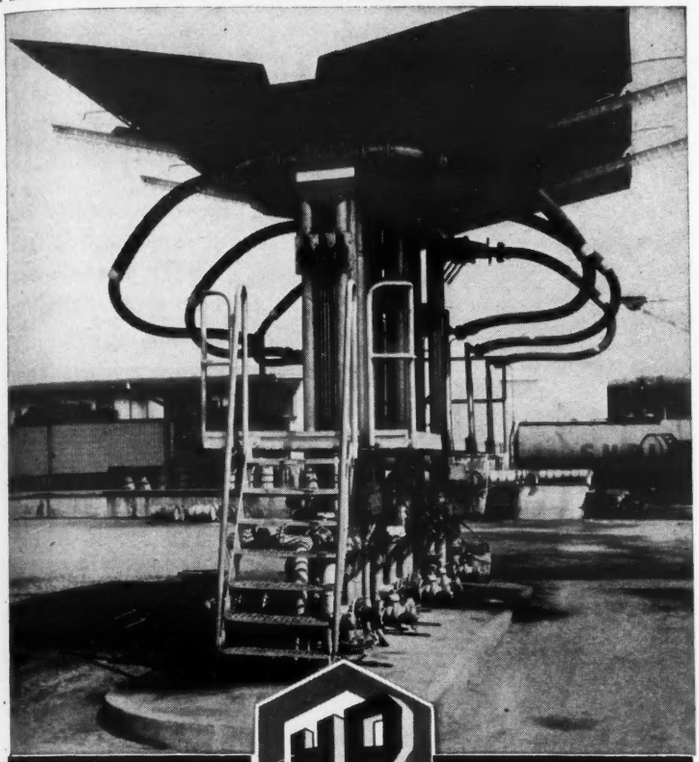

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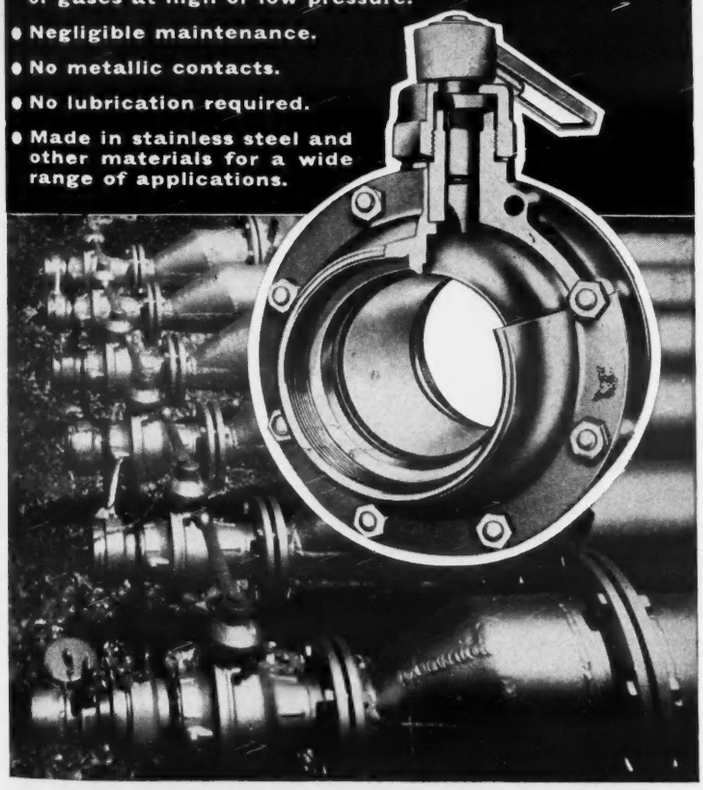

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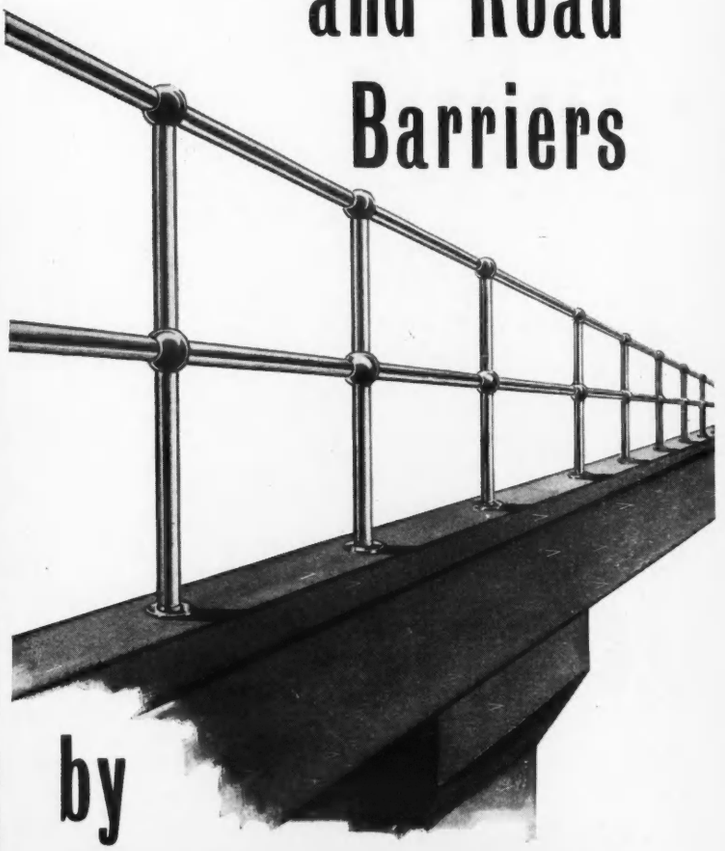

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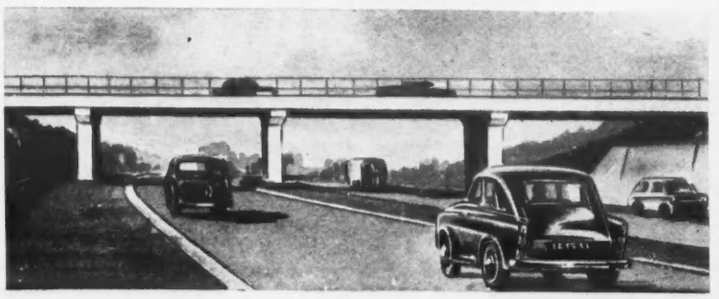

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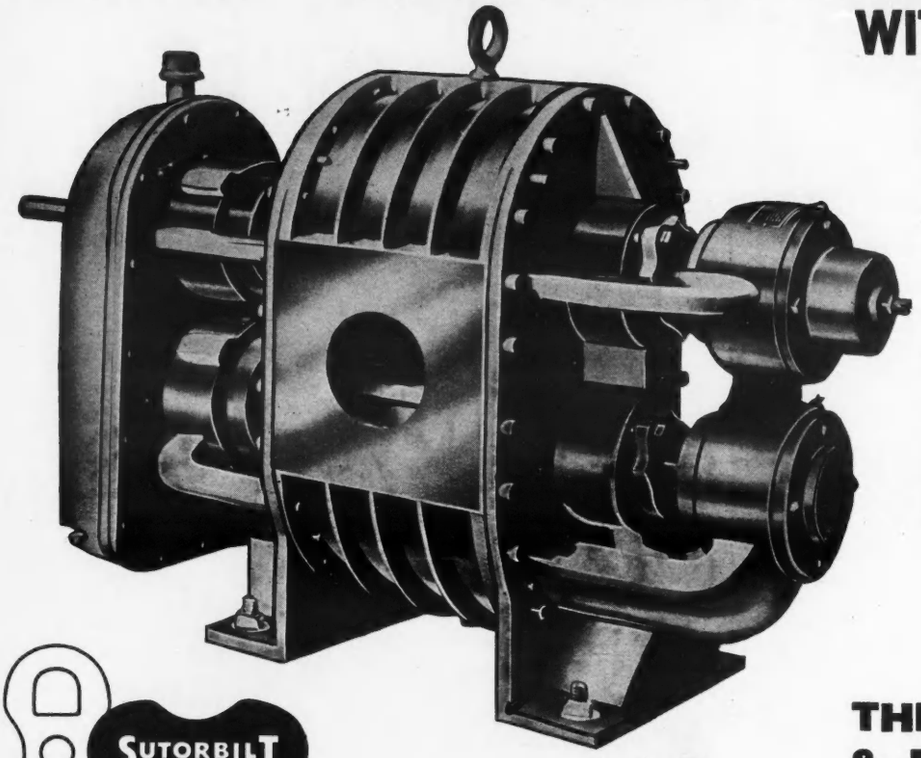

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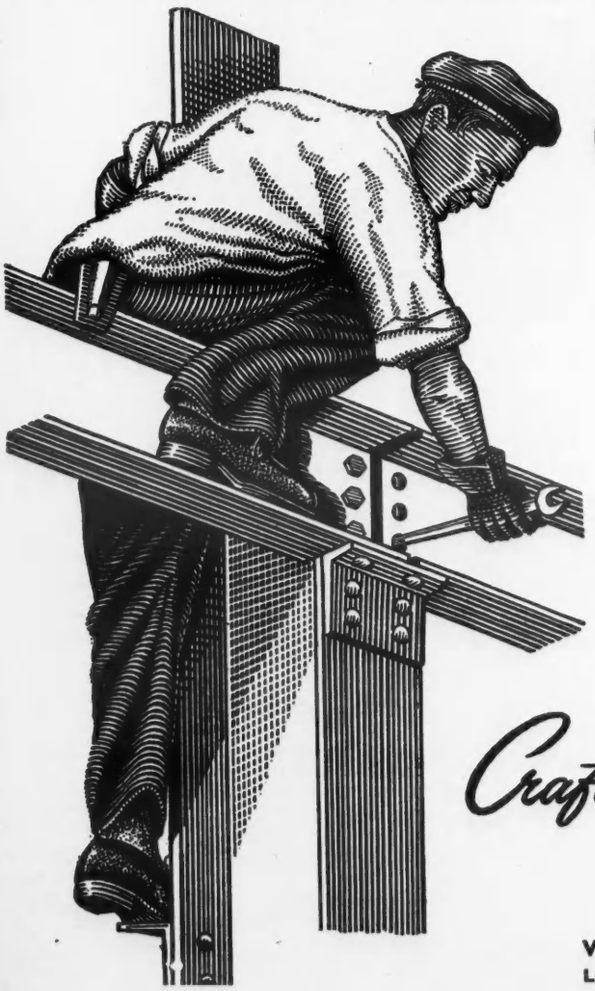

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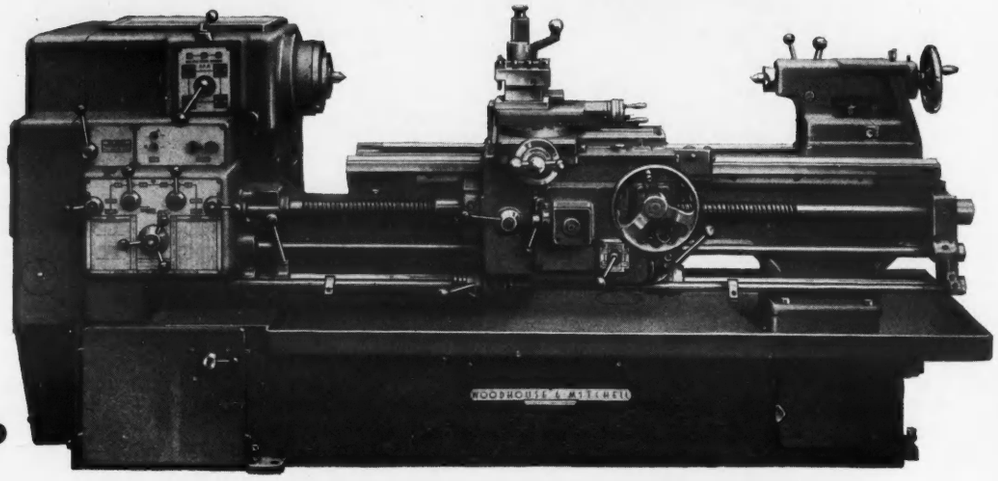

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8½ in. size: 10 h.p. motor, 12 speeds 21-945 r.p.m.
10½ in. size: 12 speeds 14-630 r.p.m. (alternative: 21-945 r.p.m.).

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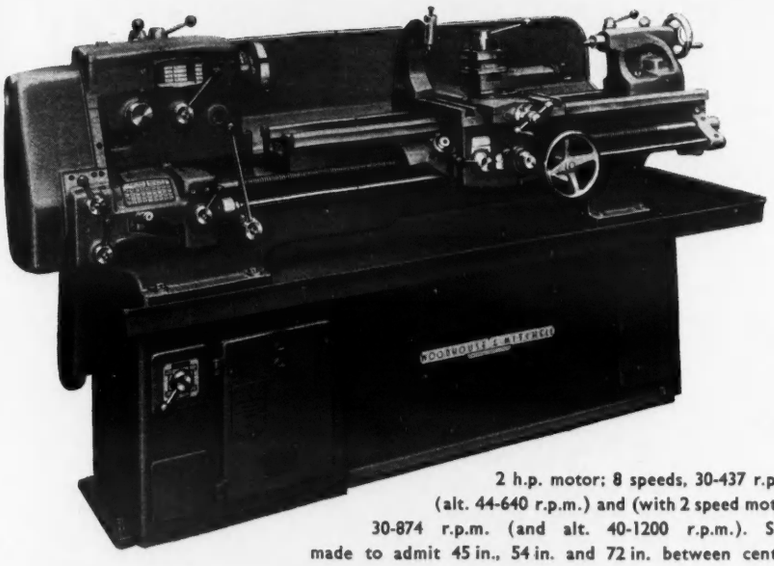
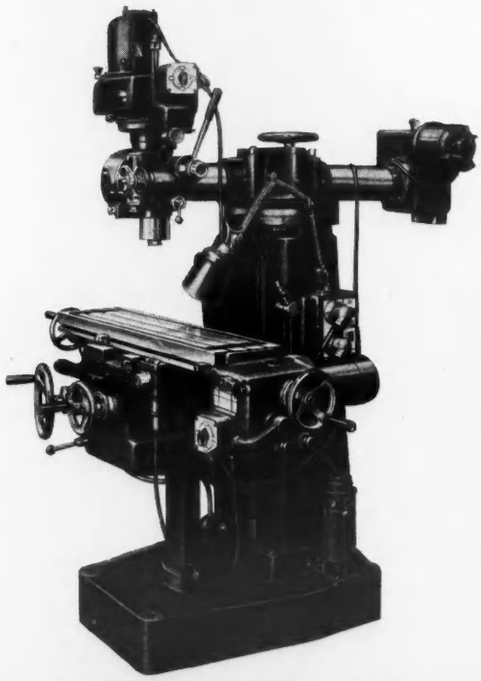


2 h.p. motor; 8 speeds, 30-437 r.p.m. (alt. 44-640 r.p.m.) and (with 2 speed motor) 30-874 r.p.m. (and alt. 40-1200 r.p.m.). Sizes made to admit 45 in., 54 in. and 72 in. between centres.



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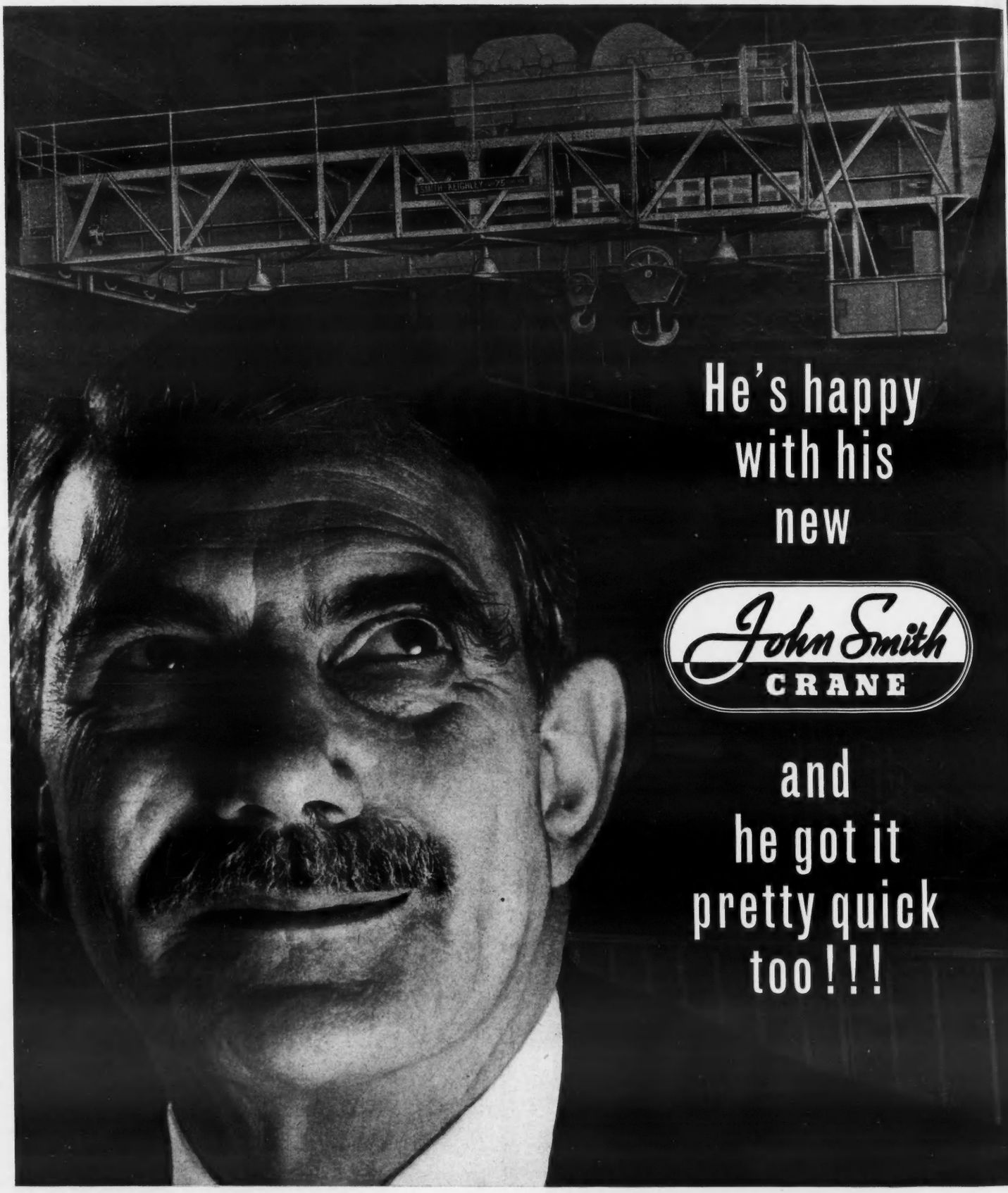


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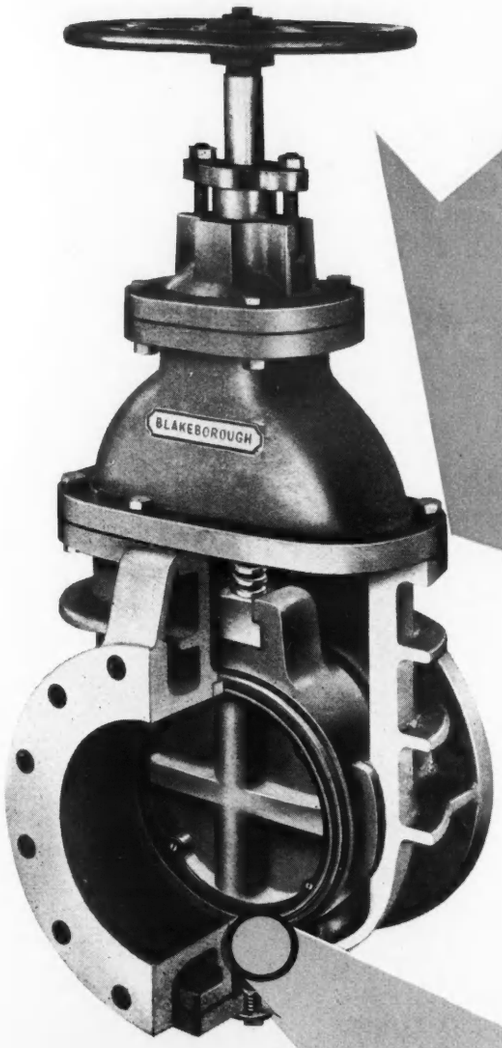


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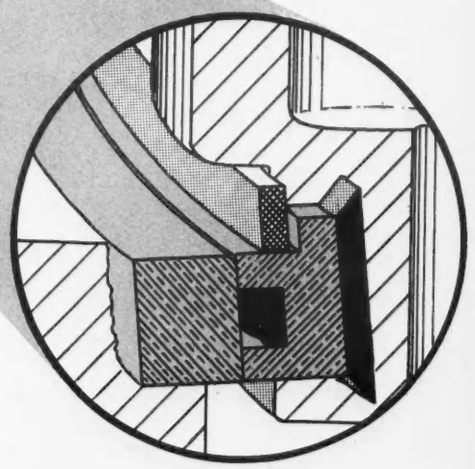

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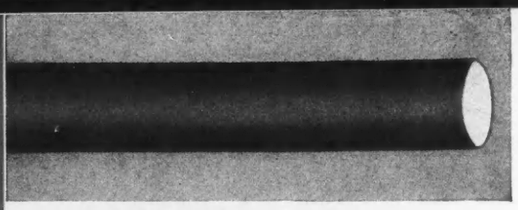

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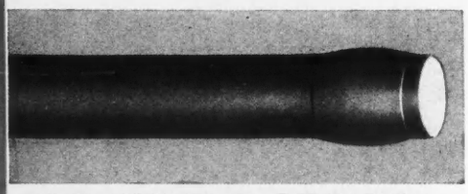

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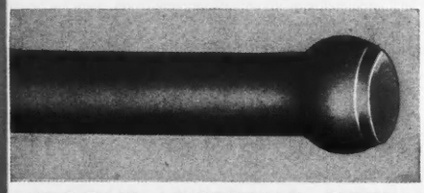
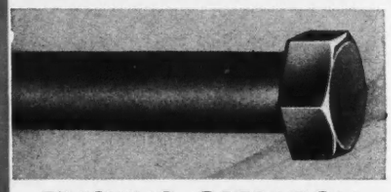


SECOND UPSETTING OPERATION



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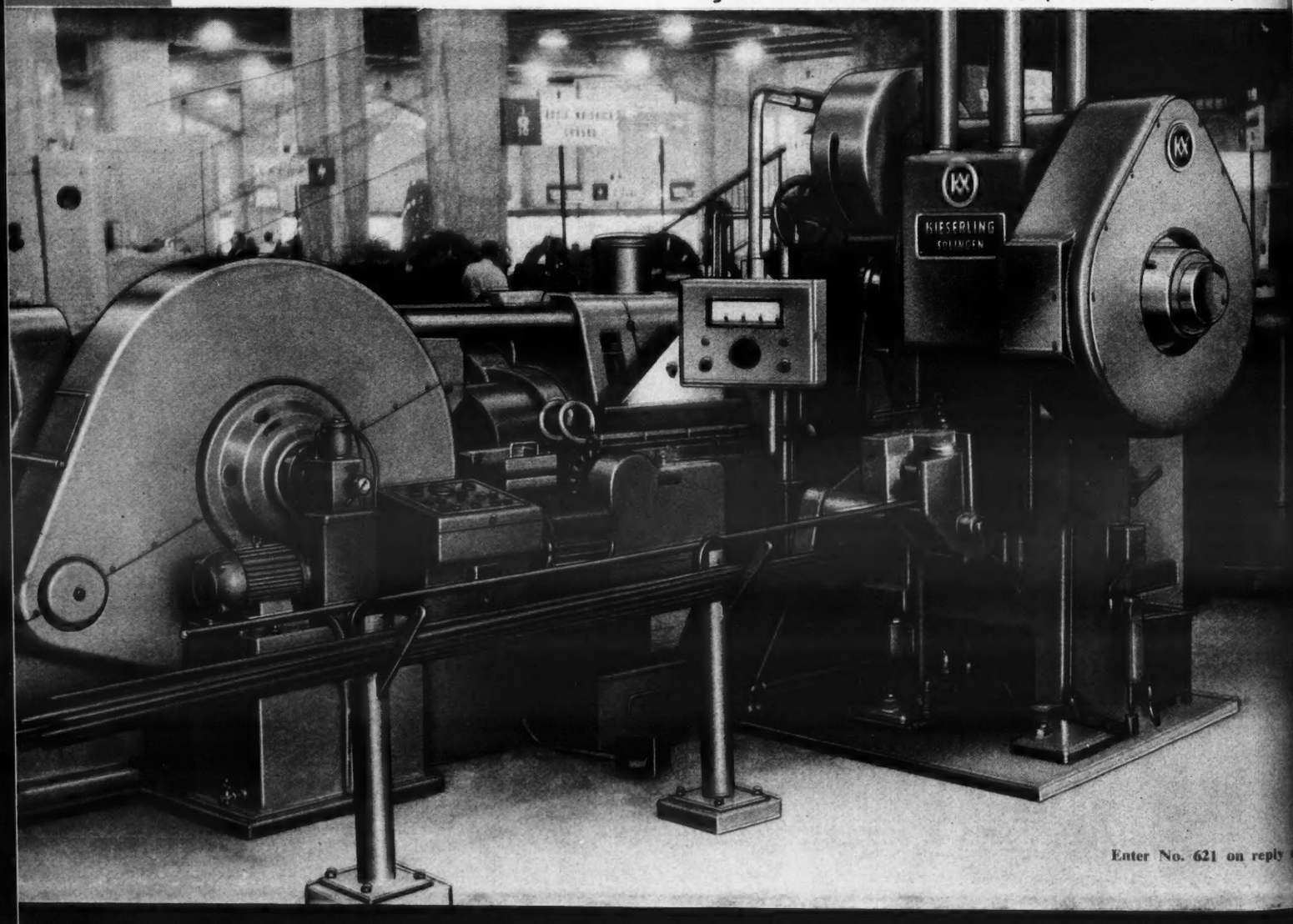


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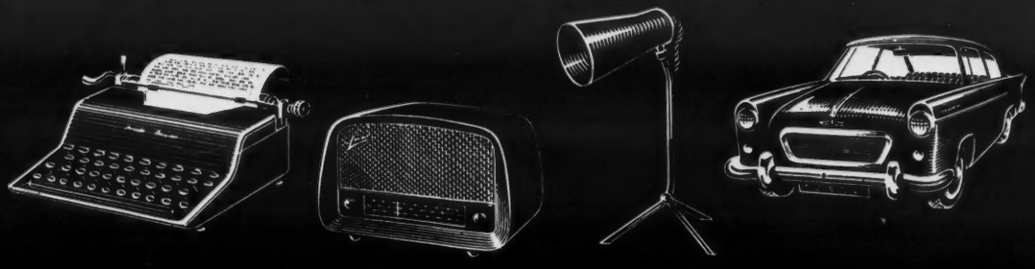

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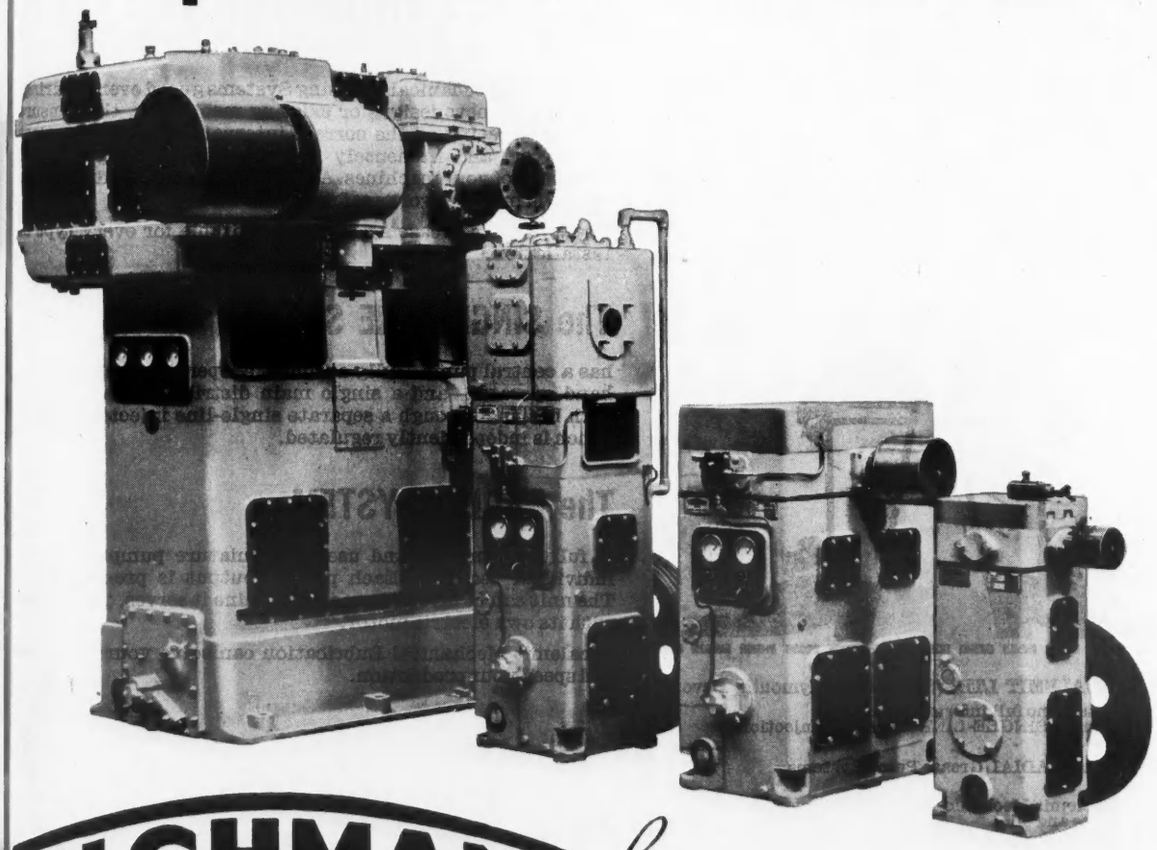

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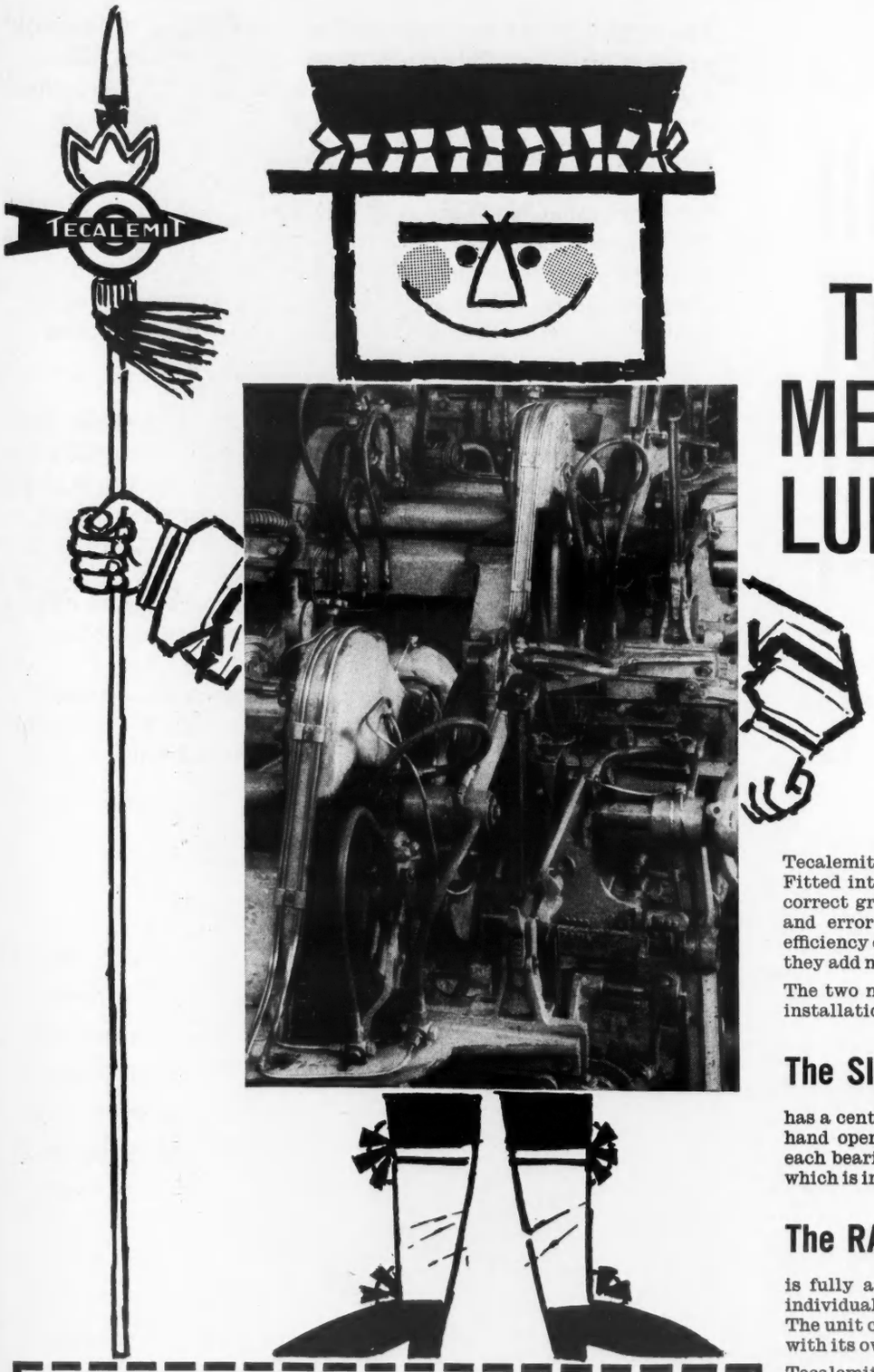


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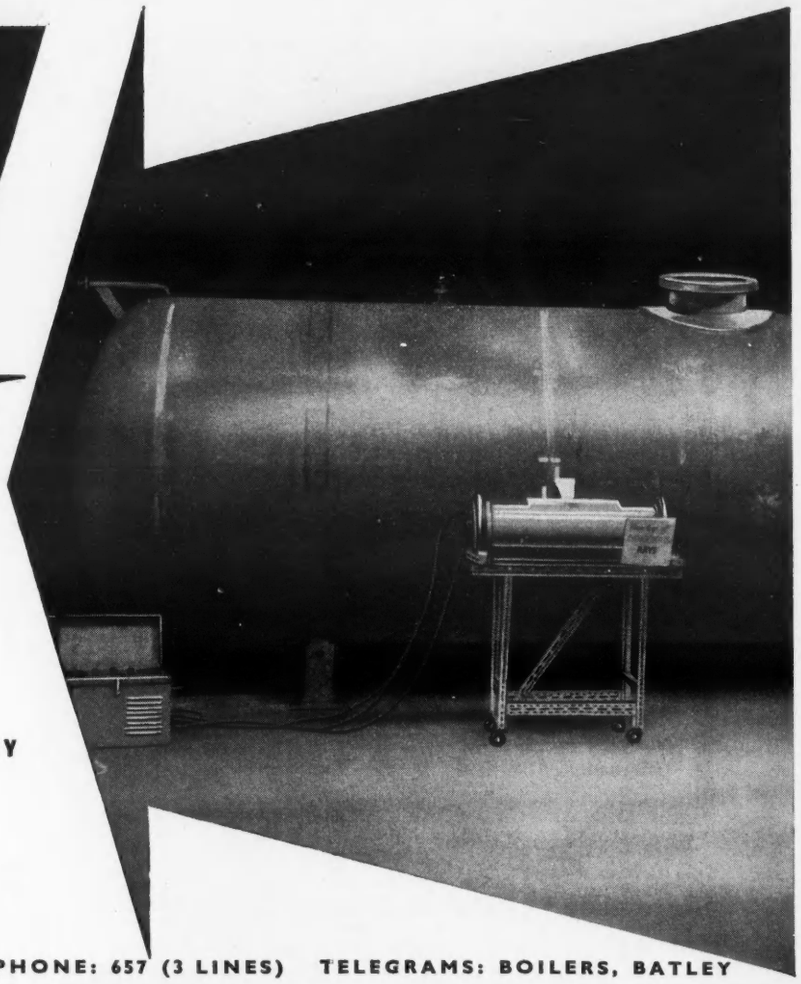

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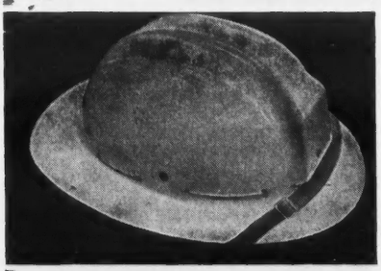

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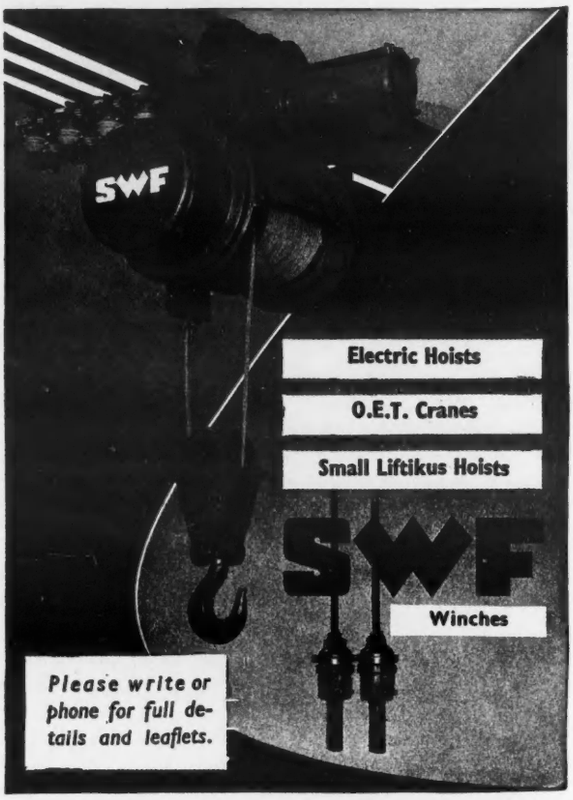


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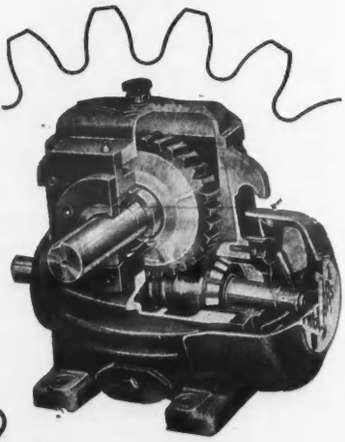

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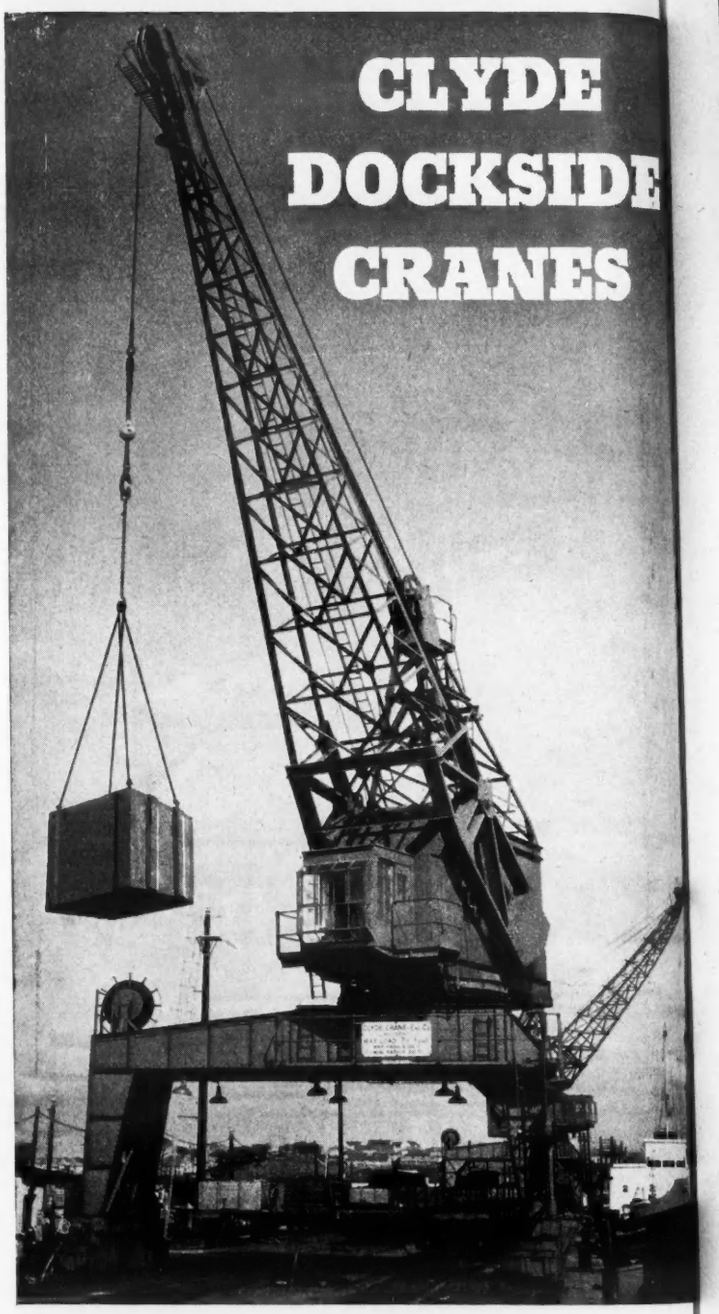


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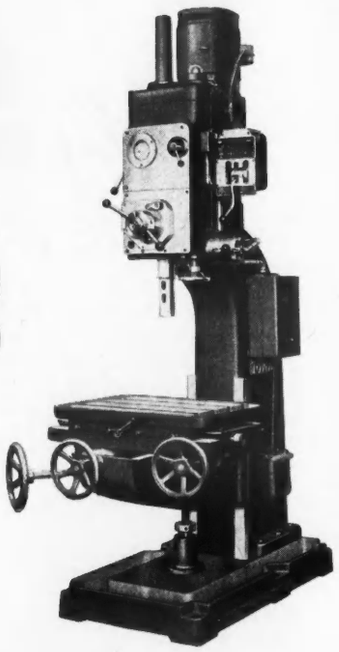

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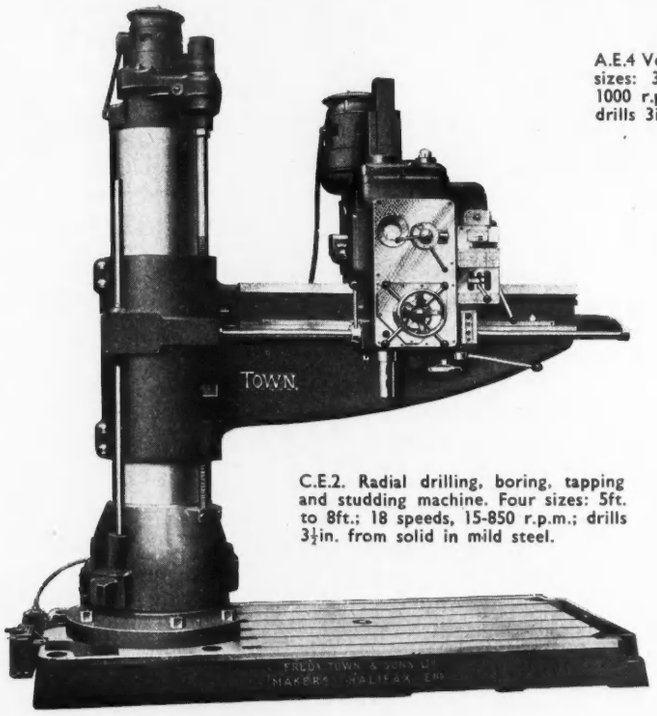


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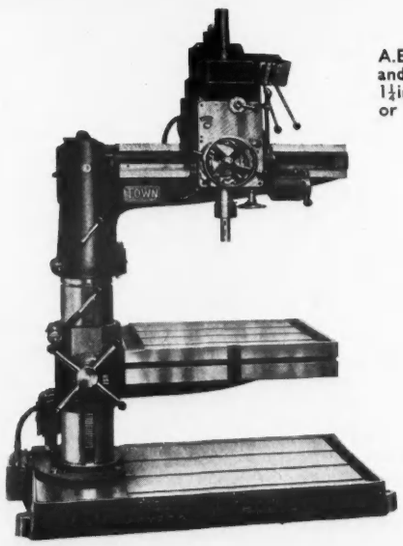


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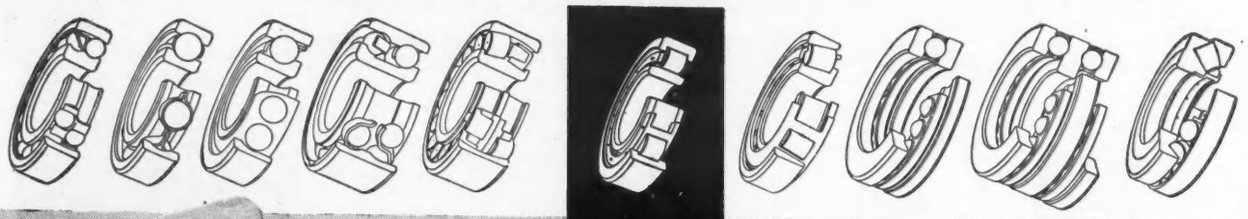

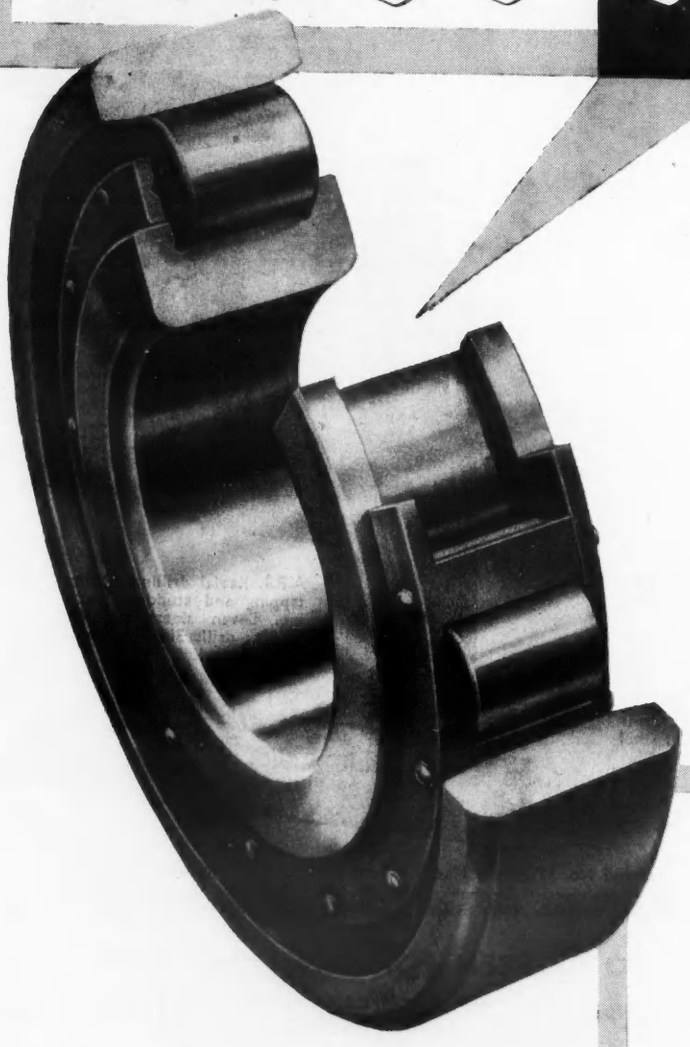

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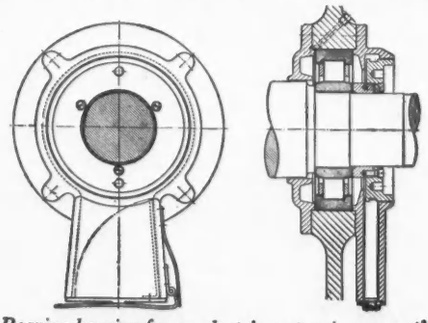

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# THE ENGINEER

No. 5448 JUNE 24, 1960 Vol. 209

## NUCLEAR POWER SLOWDOWN

Since the provisional nuclear power programme of 1955 was presented to Parliament, thermal power stations have advanced rapidly in generating efficiency with the commissioning of sets working at high steam temperatures and pressures, while the capital cost of stations has been reduced by installing fewer sets of greater individual ratings. On the electrical side, measures such as direct cooling of rotors and water-cooled stators have contributed to economy by increasing the output obtainable from machines of a given size. By the time the accelerated nuclear programme was first announced in March, 1957, the commissioning of 100MW sets had already begun and the first of 120MW capacity followed in the next year. Average thermal efficiencies were rising and had gone up from 24·35 per cent in 1956 to 25·51 per cent at the period of the accelerated programme for nuclear stations. The upward movement has continued to an average thermal efficiency of 26·36 per cent in 1959. These trends were bound to make some difference to the relative importance of nuclear and thermal power in a national programme. The decision taken at the beginning of 1957 to increase nuclear capacity compared with the 1955 proposals was governed by the prevailing fuel situation, and the lowering of the target in September of the same year was made necessary by restrictions on capital investment. Since then the part that thermal generation can play has become more important both by reason of the technical advances mentioned above, and of a changed fuel situation in which coal has become plentiful and oil supply prospects have also improved, while advantages are already being gained from the policy of siting new power stations on or close to sources of low-priced coal. In these circumstances the need for an immediate and sharp acceleration in the rate of ordering nuclear capacity has passed.

A revised programme for nuclear power is put forward in a White Paper, "The Nuclear Power Programme," (Cmnd. 1083, H.M. Stationery Office. Price 4d.) published last Monday. It points out that if the amended 1957 target of 5000MW to 6000MW of nuclear power by the end of 1966 were to be retained, the electricity authorities would have to place exceptionally large orders for nuclear capacity during the next two years for commissioning in 1965 and 1966. It has, therefore, been decided that the target of about 5000MW capacity should be advanced to 1968, which will mean continuing to place orders for nuclear stations at the rate of roughly one every year. At present, conventional power costs are about 25 per cent less than nuclear costs in the United Kingdom, and the break-even point between the two will not be reached as early as had been expected. The Government is now advised that nuclear generation for base load purposes is likely to become cheaper than thermal generation by about 1970. Continued experience by the research and design teams of the nuclear power consortia is necessary if this stage is to be reached in a reasonable time, and at a Press conference on Monday the Minister of Power expressed the opinion that the programme which the White Paper contained was perfectly adequate for the health of the consortia. It was absolutely essential for the future of nuclear power, he said, that the consortia should be kept in being and kept active.

The present position is that the five nuclear stations now being built will provide 1875MW when all on full load in 1963-64, while another 1050MW will be contributed by Dungeness and Sizewell by 1965-66. The order for Dungeness is expected to be placed in the next few weeks and that for Sizewell by the end of the year. Thereafter, there will be one order per twelve months. Had it been decided to reach the 1957 target by the end of 1966, three more 550MW stations would have been necessary. The slow-down seems likely to have its most immediate effect on the U.K.A.E.A. itself, which will have to carry stocks of fuel for a longer time than had been foreseen and will incur a loss estimated at some millions. As far as the consortia are concerned, the situation calls for them to preserve their confidence in the future of nuclear power and to maintain their efforts in the interests of this country's home power programme and potential export business.

## LAND IRRIGATION AND WATER SUPPLY

So plentiful is rainfall in this country that up to date it has never proved necessary to subject abstraction of water from surface and underground sources to any really effective control. Farmers and industrialists, when riparian owners of land, have been able to pump out as much water as they desire for any purpose, subject only to the possibility of someone bringing an action at common law against them. As against that relative freedom to abstract water, the law does have a good deal to say about the condition of any water which is put back into the river, though it is to be remarked on that subject that appeals to common law have often recently proved especially effective in preventing pollution. Now, however, there is a growing danger that the supplies of water in rivers, especially in the eastern counties, will fall far short of demand. The reason lies in the rapidly increasing use by farmers of river water for irrigation of crops. According to a sub-committee of the Central Advisory Water Committee, the relevant and very recent report of which—a very short one—lies before us as we write, "We have received sufficient evidence to convince us that there is now a risk that growing abstractions may seriously deplete the natural flow of many rivers and streams. The chief of these abstractions is for irrigation which is increasing apace, and which if not regulated could overtax water resources, at any rate in some areas, since little, if any, of the water abstracted is returned and the heaviest demand tends to occur when flows are at their

lowest . . . We have concluded that, in the circumstances, where the situation calls for such a step, abstractions, notably for irrigation where the water is substantially consumed without return, should be subjected to control." The sub-committee expects to make a report later on "such matters as the form of authority to operate any system of control and the method of operation." Since at present all that a farmer has to do is to take a tractor fitted with a pump to the riverside and drop in a suction pipe, the problem of working out an effective method of control may well prove difficult to solve, more particularly because there will be no desire wholly to prevent the use of water for irrigation, but only to control it so that the available water is fairly divided amongst riparian users and the flow in the river is not reduced below some safe level. The sub-committee goes on to remark, "While in the short term some control of abstractions is, in our view, unavoidable, we cannot emphasise too strongly that in principle the ultimate object should be a form of control which would also provide for conservation and storage so that water would be available for all legitimate purposes."

In a previous report the sub-committee recommended that hydrological surveys should be made of the rivers of this country. The first publication of such a survey conducted by the Surface Water Survey of the Ministry of Housing and Local Government occurs in a document which has just become available from H.M. Stationery Office and which relates to the River Great Ouse. It provides a great deal of information about the amounts of water abstracted from that river and the effluents returned to it. For the whole length of the river a "water use balance sheet" — a most revealing tabulation — is drawn up detailing the situation of each point at which water is abstracted or returned to the river, together with the estimated amounts involved. It is made very apparent that the water is used over and over again as it flows downstream. Fortunately, there appears to be little pollution. Estimates are offered of the likely effect of using water for irrigation, supposing there to be no control. A calculation shows that for the Ouse basin alone, were all land worth irrigating provided with water, the demand would be equal "to about half the total supplied daily by water undertakings in the whole of England and Wales!" The river cannot possibly supply such an amount. Demands for irrigation water are at present relatively low, but are increasing at a rate of about 15 per cent per year, with the consequence that "it is difficult to escape the conclusion that if the present rate of expansion continues, in five years time when the present demand will have doubled, the condition of the river may well have become intolerable." Even if storage reservoirs were created at suitable locations in the watershed only a fraction of the total prospective demand could be met. The compilers of the Survey comment that the whole demand could only be met "by the demineralisation of sea-water, or by bringing water from those parts of Britain where the rainfall is high and the opportunities for storage are greatest." If the latter expedient were to be adopted it would have to serve, of course, an area much larger than that of the catchment of the Great Ouse alone. The conclusion must be drawn that it could only be done by the creation of a really effective water grid properly supervised by some national authority. But since much of the area in which irrigation would be beneficial is low-lying and not very distant from the sea it may well be that firms specialising in distilling sea-water will be able to provide fresh-water more economically. We hope so; because we have no more desire than the local inhabitants to see the delightful rivers of the Western and wetter counties of this country denuded of water.

## THE ROAD PROGRAMME AND NATIONAL PROSPERITY

How fortunate, if uncomfortable, is our Government in having such an able and vigorous critic of its road programme as Lord Derwent. In his speech on June 16 at the annual general meeting of the British Road Federation, Lord Derwent pungently reviewed the present state of the road programme, pointing out that on the basis of present intention—i.e. spending some £68,000,000 to £70,000,000 per year—it is possible to forecast the entire road achievements in the lifetime of this Government. By 1964 the most intractable part of the problem—urban congestion—will still remain to be solved. The Federation would like to see this rate of expenditure (which refers to major new construction only) trebled; that would compare with the programmes set out at the "Civils'" highway conference held in 1957 and it is, without doubt, a very reasonable proposal. The present programme is especially inadequate in relation to urban roads; the recently completed M.1 is to its credit, but since its completion last year it has not been replaced by a project of comparable size to give continuity to the programme. With the continued increase in motor-vehicles, and with spare capacity in the contracting industry, there is every justification for Lord Derwent's attitude. "One cannot but admire," he says, "the audacity of the Treasury in sitting on a total tax income of some £5,000 million a year, and claiming that something less than 2 per cent of that sum is the limit of what can be found for road modernisation." (Incidentally, more than £600 million of this tax income is from road users.) He was particularly critical of the suggestion that toll roads should be built, since, in towns and cities, where the crux of the problem lies, the collection of tolls would be so cumbersome as to be impractical. On parking, he pointed out that, in the light of the present Ministry of Transport policies, it would seem that in the future we would be encouraged to "travel hopefully," but it would be a criminal offence to "arrive"!

These brief quotations, however, barely do justice to what is clearly a positive and highly constructive attitude. Road transport is now such an important element in the nation's economy that the fundamental facts can no longer be pushed aside and neglected. One more quotation from Lord Derwent presses home this point: "The measure of the roads crisis is simply this. We have reached the point where the financial costs of accidents —leaving out altogether, if that is ever possible, the sum total of human suffering and misery they cause—plus the costs of waste of time, fuel and other factors, is just about equal to the annual increase in the total productivity of the nation. This is a strange equation, for it is upon this last factor that we pin our hopes for a doubling of living standards in the next twenty-five years. . . . The real answer to crowded roads is modernisation on a scale not yet attempted."

Probably one factor which weights lay opinion against this obvious truth is that roads like the M.1 are not associated, popularly, with low accident rates, and it is very difficult to convince people that a high-speed road, properly designed, is a safe road. The Road Research Laboratory tells us that the M.1 is saving about twenty lives a year. They also tell us that 1 per cent of the road system carries 25 per cent of the traffic, and 10 per cent of the roads, correspondingly, 60 per cent of traffic. It

would be an interesting exercise—one perhaps with which the British Road Federation could supplement its progress charts of the road programme—to find out (*a*) how comprehensive are the improvement schemes already approved for this very critical 1 per cent of roads, (*b*) how many lives are lost each year on them and (*c*) what would be the effect in economic benefit and saving in life if this 1 per cent were brought up to, say, M.1 standard, at present traffic figures, and at the estimated 1964 figures with 12,000,000 vehicles in use.

## THE PROSPECT OF CLEAN RIVERS

A brief report of the Institute of Sewage Purification's annual conference appears on page 1075 of this issue. The technical matters before the conference—the possible future use of fuel cells and progress in making a "purifiable" detergent are the two matters discussed in our report—are of great interest, but it is the broad attitude towards the whole problem, as explained by the President, Mr. Kershaw, in his address, which attracts the widest interest. For he concerns himself with, and identifies the Institute with, "our national heritage—the rivers of this country"—and looks forward to seeing them in a clean and healthy state. One technical problem in purification, that of the treatment and economic disposal of sludge, has not been tackled in a forthright and purposeful manner, Mr. Kershaw asserts, and more effort towards its solution is urgent. But on the more general theme of clean rivers he says: "The most important step forward in trade effluent and river pollution prevention work in the post-war period is undoubtedly the findings of the Trade Effluents Sub-Committee of the Central Advisory Water Committee contained in their first report published in December, 1957, and the second and final report published in January, 1960, under the chairmanship of Sir Frederick Armer. With a patience and thoroughness reminiscent of the old Royal Commission, this committee has sifted a vast amount of written and verbal evidence and produced conclusions and recommendations which, if acted upon, will establish a great advance in effective control of industrial effluents. With such constructive work as this being produced at national level we can look forward with confidence to the future work of this most important branch of sewage treatment and river pollution prevention."

Another of last week's events further emphasises how important and how topical is this subject today. On page 1076 we reproduce some remarks made by Mr. Henry Brooke, Minister of Housing and Local Government, when he opened the new sludge digestion plant at Minworth. The most important point he made was that consideration is being given to the broadest, and indeed the only really satisfactory approach to the whole problem, namely, "a plan for the river basin as a whole which would serve to reconcile all demands . . . while making as much water available for use as possible." The regrouping of water undertakings into fairly large, regional organisations is clearly desirable, but is a limited aim, and the wider objective of river authorities with overall responsibilities of conservation is much more satisfactory. The great demands now made on water authorities, and the higher standards sought both in the immediate tasks of water supply and sewage disposal, as well as in the recognition that a river must be a clean and pleasant thing in itself, all stress how desirable, indeed how essential, it is to recognise and act upon this principle on a national scale in a short period of time.

## OIL IMPORTS AND THE COAL INDUSTRY

In an address at the conclusion of the annual conference of the Association of Mining Electrical and Mechanical Engineers last week, Sir James Bowman, chairman of the National Coal Board, dealt with some of the problems confronting the coal industry and the measures being taken to meet the challenge of competition and changing circumstances. He said that the industry was now facing one of the most critical stages in its history and the future would be one of continuous challenge from competitors, particularly by-product fuel oil from refineries. Sir James did not consider it unreasonable for British refineries to seek home markets. What was causing concern, however, he said, was that an increasing amount of heating oil was being imported and made available at prices below those of the crude oil from which it was produced.

It might be argued by consumers that the coal industry should compete with oil on a cost basis; but such competition with a low-priced by-product by an industry still in process of re-organisation and re-equipment is virtually impossible. Other steps may, therefore, be advocated if the future security of the coal industry is not to be placed in jeopardy. Indeed, in Western Germany heavy taxes have already been imposed to protect the coal industry and it is expected that similar steps will be taken in France. Already a large amount of the fuel oil sold in this country comes from overseas and there is every possibility that other countries imposing taxes to preserve their own coal industries will do their utmost to export surplus oil to Britain. If the vast amount of money and work which has been put into the modernisation and mechanisation of the collieries in this country, to increase efficiency and promote economic production, is not to be wasted before the benefits are felt, the question of marketing calls for immediate consideration.

## The Engineer—100 Years Ago (JUNE 22, 1860)

"THE NEW HOUSES OF PARLIAMENT"

"About four o'clock on Friday morning, as police-constable 112A was on duty in Palace-yard, near the entrance leading to the reporters' gallery, a large mass of stonework, forming the canopy to the niche containing the statue of Charles the Second, broke away and fell to the ground with great violence from a height of about 50ft, and within a foot of where the police-constable was standing, smashing the pavement by the violence of the concussion. The only reason that can be assigned is the very rotten and rapidly decaying condition of the stone in different parts of the building, expecially in those parts where there are ledges or projections. Several men are engaged daily in applying a solution to the more decayed parts with brushes; but this process is considered by many persons as a very doubtful attempt to stop the dilapidation which is now going on."

"PASSENGER SHIPS"

"An official return, just issued, of the number of passenger ships that cleared from ports in the United Kingdom, under the Passengers' Acts of 1852 and 1855, shows that in the years from 1853 to 1859, inclusive, 2,439 British ships, of an aggregate of 2,162,039 tonnage, and 2,032 foreign ships, of 2,486,646 tonnage, left the United Kingdom—the British ships carrying 567,651 passengers, and the foreign 721,467 passengers. Of these, 814,483 went to the United States, 120,760 to the British North American possessions, 313,187 to New South Wales and Australia, 26,026 to New Zealand, and 14,662 to other parts."

# Mechanical Engineering Researches

*The National Engineering Laboratory, East Kilbride, last week held Open Days and published its annual report for the first time since the former Mechanical Engineering Research Laboratory was re-named. We describe and illustrate below some of the work recorded and displayed.*

THERE was appointed on April 1, 1959, a National Engineering Laboratory Steering Committee, under the chairmanship of Vice-Admiral Sir Frank Mason, K.C.B., to be responsible to the Research Council for the selection of research projects and the preparation of research programmes for what is now called the National Engineering Laboratory. The Steering Committee has decided to give priority to projects which are directed towards immediate industrial problems, or which promise application within a relatively short period. The Laboratory gives particular attention to topics of value to the machine tool industry.

Some work of the N.E.L. was discussed in detail in No. 1 of our series "Industrial Value of D.S.I.R. Research," April 29, 1960, and is not discussed further here. One particular field in which not only research but also development work has been carried out is on hydrostatic systems for the transmission of energy, and while such systems, which are of course widely established in industry, are usually regarded as inherently noisy, the N.E.L. has evolved detail refinements which allow such devices to qualify for service in submarines. The principal difference between the new pump and existing

**Pump for submarine service : it is driven through a rubber coupling and supported in rubber bushes**

swashplate pumps is that, instead of the cylinder-block being free to seat itself on the port plate, the cylinder-block is fixed and the port plate is floating ; the oil pressure developed by the pump is used to support the port plate. This system implies that a finite amount of oil is lost at the ports, but the pump can be so designed that this loss is not important. A significant advantage with this construction is that the port plate can be rotated to vary the port timing, and this allows the pump to be rendered quiet all through its operating range ; it is found that the port position for minimum noise is not objectionably far from the port position for maximum efficiency. (The change of timing is, of course, applied indiscriminately to all four events, opening and closing of inlet and exhaust.)

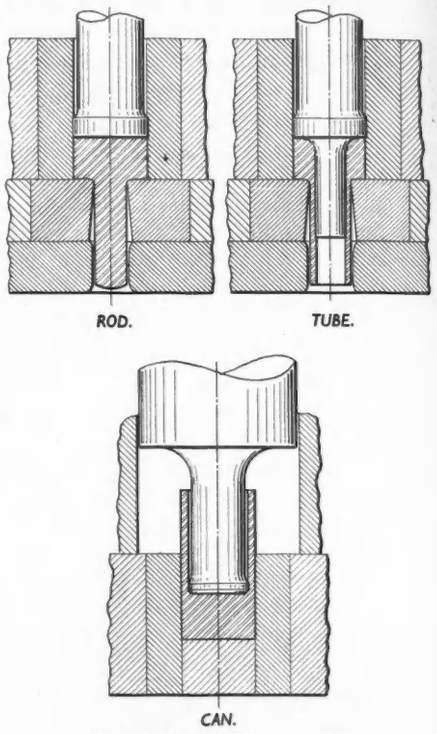
Pumps are built with automatic timing variation, sensing simply pressure differential. This new form of construction not only simplifies and vastly cheapens the pump, but also suppresses mechanical noise, since plain bearings for the shaft are adequate. The pump has been further silenced by mechanical refinement, e.g. stiffening the swashplate to force up its natural frequency, preloading the swashplate between two opposing rams or adjusting screws. The noise that is generated is insulated by mounting the pump on flexible rubber bushes, and the shaft is driven through a "Fennaflex" flexible coupling. It is expected that pumps running on these principles will encompass speeds of 3000 r.p.m. and pressures up to 5000 lb per square inch ; an overall transmission efficiency of 87 per cent has already been demonstrated. We illustrate a Towler pump made for the Admiralty ; a licence to use N.E.L. patents on this pump has been acquired by Boulton Paul Aircraft, Ltd.

While this pump runs satisfactorily as a motor, the Laboratory has also developed motors for direct coupling to plant. A feature which distinguishes the N.E.L. design of radial motor is that reciprocating cam-operated valves are used, so that both ends of the crankshaft are free, and this facilitates the construction of multi-bank units for high torques. The valves are provided with variable timing by helices in the manner of fuel injection pumps.

Pumps and motors such as those above are considered well suited to applications calling for silence, reasonable efficiency, reliability, low weight, and ease of control, and thus for, say, automotive transmissions. For machine tool applications, where relatively low powers and utilisation are involved and low cost is important, a radial-cylinder pump using steel balls as pistons has been evolved. Wear of the balls has been reduced by designing so that the balls roll and not slide on the cam ring, and special treatment has avoided wear of the cylinder bores.

As is well known as a result of, for instance, exhibiting at the Physical Society Exhibition, the movements of machine tool elements can be monitored accurately by exploiting the amplifying properties of Moiré fringes. The Laboratory has exploited this facility to improve the accuracy of generated motions by incorporating automatic error correction ; sets of gratings on input and output are monitored, and any tendency for the velocities to change from the desired ratio is corrected by a small servo motor driving a differential in the motion. The ultimate application of these principles would, of course, be to compare the output with a computed desired value, but it is believed by the Laboratory that the computer-controlled tool will be condemned for some years to come to accuracies no better than 0.0005in. We illustrate a model demonstrating the technique of automatic error correction ; a gear hobbing machine incorporating these principles is displayed at the International Machine Tool Exhibition (see page 1043).

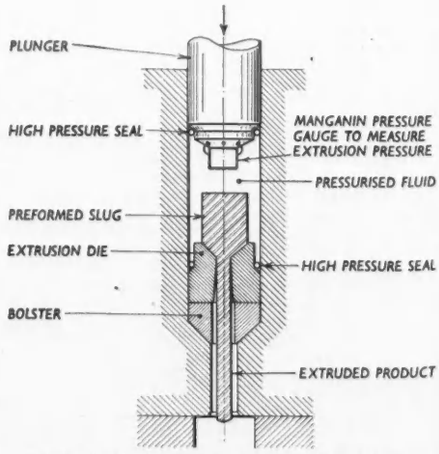
The production of gratings of the fineness required for these applications—typically 10,800 radial lines—by N.P.L. methods is extremely slow, and the time needed has been reduced from days to hours by a method of photographic reproduction. The workpiece is rendered photo-sensitive and traversed under a master grating illuminated by parallel light ; the light is allowed to reach



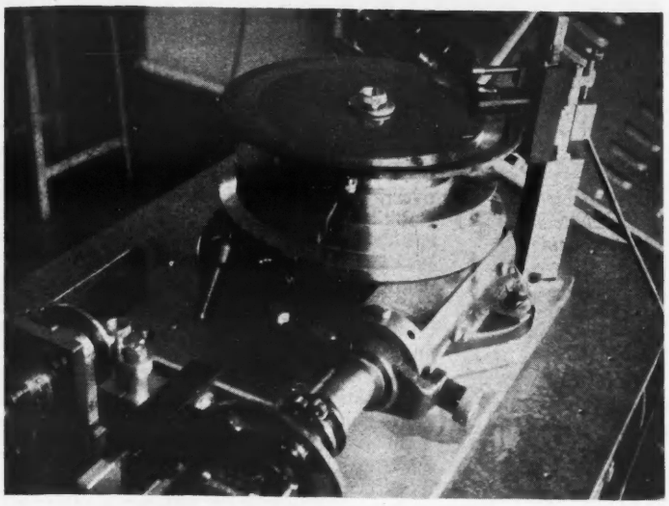

**Typical cold extrusion operations**

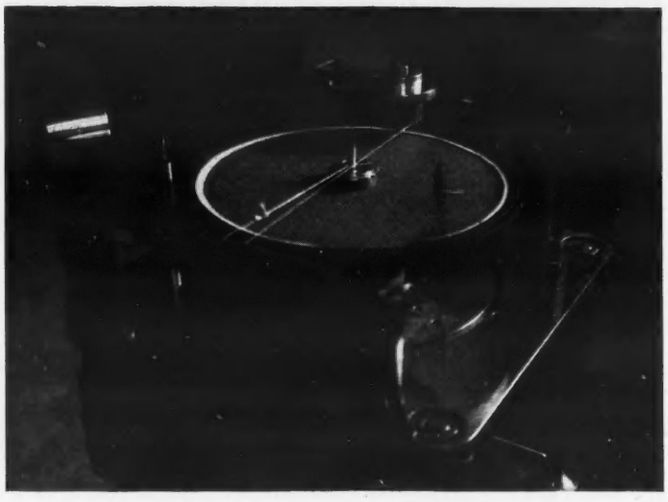
the grating for short intervals separated by the time taken for the workpiece to move one line pitch. Since each line on the workpiece is a composite image of all the lines on the original, errors in the original are suppressed.

As indicated above the Laboratory takes particular interest in machine tool problems, and emphasis has been laid on a rather extensive investigation made of the cold extrusion of steel. This process offers the prospect of greatly reduced material costs compared to processes involving chip removal and may afford higher performance due to the cold working experienced by the material. The extrusion of a variety of steels up to 18 : 8 nickel : chromium has been essayed




**Extrusion under and by hydrostatic pressure**

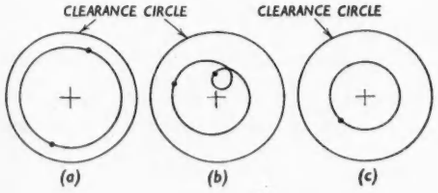




**(Left) Continuous correction of transmission errors by comparison of displacement measurments at input and output made with Moiré fringes : the corrections are introduced by the differential in the foreground. (Right) Rig for performing standard abrasion test : the test piece is rubbed in a spiral over the disc**

for three basic forms as illustrated ; variables studied have included ram speed, tool design, lubrication, and extrusion ratio. The work has been done on a conventional press for ram speeds of the order of inches per second. It should be made clear that the investigation has not covered working at such rates that hydro-dynamic effects obtrude, as is the case in United States practice (see page 985, December 19, 1958) and in the process used in this country by, for instance, Forgings and Presswork, Ltd.

This investigation of the extrusion of metals by the Plasticity Division showed that brittle metals which cannot be extruded in the normal way, since they fall from the die in pieces, can be extruded if subject to hydrostatic pressure of an appropriate magnitude. A logical and attractive application of this technique is seen in our illustration,




(*a*) A lightly loaded shaft will tend to whirl at a frequency slightly less than half its rotational speed and at fairly high eccentricity.
(*b*) If a centrifugal load is superimposed on the gravity load epitrochoidal patterns are formed, the mean velocity again being slightly less than half the rotational speed of the shaft.
(*c*) As the centrifugal load is increased, the pattern changes to synchronous whirl at a lower eccentricity.

**Behaviour of shaft in plain bearing under gravity and rotating loads**

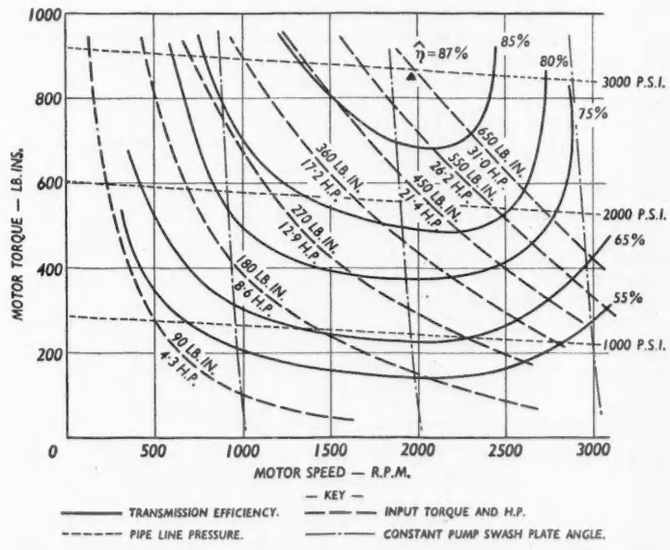
where a brittle metal is being extruded under fluid pressure ; friction between the billet and the chamber has been eliminated, and the fluid used affords lubrication of the die. Metals which are amenable to extrusion under hydrostatic pressure include magnesium, 60/40 brass, and beryllium ; the latter result is regarded as of great importance in view of the value of beryllium for canning fuel elements and of the dangers of chip- and dust- forming operations on the metal.

This demonstration of the significant effects of ambient pressure upon the properties of metals is being followed up by a programme of measuring tensile and shear moduli under high pressure. The test pieces are small cylinders, the strain being measured by strain gauges or even by direct observation, and the test being performed within a cylinder compressed in a testing machine. For tensile tests, the specimen is loaded by releasing the pressure from one side of a piston attached to the end of the specimen—for torsion tests, by a small electric motor straining the specimen through a series of gear reductions and being itself subject to the imposed pressure.

Air-lubricated bearings are used frequently by the Laboratory for the construction of highly precise apparatus, and some investigations are being made of the behaviour of the hydrodynamic bearing. A shaft is run in a plain bearing, and inductance pick-offs detect its instantaneous position. Our diagram shows the traces of shaft displacement that appear on the face of the c.r.o.; the spot is a timing mark appearing once per revolution of the shaft. The shaft speed in these experiments is far removed from the fundamental whirling speed.

Another study into lubrication and wear has been concerned with fretting corrosion, such as takes place in laminated springs and other assemblies. Since the mechanism of failure is believed to be abrasion by corrosion products, a comparison is being made of the resistances to fretting and abrasion of a number of steels and cast irons. The abrasion resistance is assessed by rubbing specimens against an abrasive cloth on the apparatus illustrated and determining the weight loss. Fretting-wear resistance has been measured at constant temperature, humidity, load, and relative movement, and a close correlation demonstrated.

The wear of cylinders in reciprocating internal combustion engines is being investigated by a method analogous to the radioactive tracer techniques used for measuring piston ring wear. A trace, 0·03 per cent, of iridium is dissolved in cast iron and a $^{5}/_{32}$in pin is made and irradiated in a pile. The pin is then inserted into a radial hole in a cylinder liner and the liner finally bored. By sampling the engine oil, the rate of wear of the pin, which, it is not unreasonable to suppose, is the same as that of the surrounding liner, can be assessed. By using different tracers, more than one pin can be monitored by gamma-ray scintillation techniques. When this method of wear measurement has been established, it is intended to investigate the proportions of wear attributable to foreign matter introduced with the lubricant and with the charge air. This technique should yield results very much more quickly than running the engine until wear reaches measurable proportions.




**Typical characteristics of hydrostatic transmission controlled by pump displacement: pump speed constant at 3000 r.p.m.**

# Large Electricity Supply Systems

## C.I.G.R.E. MEETING IN PARIS

No. I

*The eighteenth convention of the International Conference on Large Electric Systems (C.I.G.R.E.), held in Paris, ends to-day. It is concerned with technical, rather than economic aspects of electrical power systems. The subjects being discussed at this convention are power system planning and operation, insulators, lightning and surges, direct current, high-voltage cables, extra-high-voltages, transformers, overhead lines and towers, generators, relaying and circuit breakers. Below we give a short résumé of the first session, on June 16, covering power system planning and operation.*

As power systems grow in size, so the most economic voltage of transmission tends to rise. Alternating current systems operating at 380kV have been in service for some years in Sweden and Russia where power has to be transmitted over long distances. The first stages of a 330kV system are in operation in Australia. A 400kV system is due to come into service in Finland this year. In Germany a 380kV line was commissioned in 1957. In America there is a 345kV transmission system and it is planned to go to higher voltages—possibly 460kV in 1962 and 650kV in 1975. At voltages of this order direct current becomes competitive for transmission over long distances and in Russia an 800kV (±400kV) system is being built to transmit 750MW between Stalingrad and Donbass. Direct current is competitive, too, for submarine interconnections, and the cross-Channel cable to link the power systems of Great Britain and France exemplifies progress in this direction. At the same time the growth in the size of power systems is reflected by corresponding increases in the size of individual generating sets, and units of 550MW are on order in more than one country.

This bare recital of facts provides a rough background against which one may view the proceedings of the current C.I.G.R.E. convention.

The two main topics discussed at the first technical session of C.I.G.R.E., on Thursday, June 16, were (i) Power System Planning and Operation and (ii) Insulators. At this conference the scope of the first topic "Power System Planning and Operation" is taken to include a study of power system stability, power frequency control, voltage regulation and associated matters.

### Power System Planning and Operation

To guide and discipline the discussion of this topic the papers[1–21] considered at this session were divided into four groups :

(i) load frequency control between interconnected networks ;

(ii) network transient operation ;

(iii) research on network equipment and planning ;

(iv) aids to calculation ;

and were prefaced by introductory remarks by the special reporter (Monsieur Magnien, France), who indicated some of the questions upon which the discussion might be focused.

(i) *Load Frequency Control Between Interconnected Networks.*—Monsieur Magnien traced the development of this subject by recalling that at earlier C.I.G.R.E. sessions, in 1948, 1950 and 1952, most of the relevant papers were concerned with primary control, exercised solely by turbine speed governors. At later sessions (1954, 1956 and 1958) many of the papers dealt with power-frequency control systems and the research and development work behind them. Papers at the present meeting appeared to emphasise theoretical research on the characteristics of the very large regulated system formed by a group of networks equipped with frequency control and, ultimately, with automatic devices for controlling tie-line power flow. It would be wrong, in Monsieur Magnien's view, to infer from these theoretical studies that serious practical difficulties had been met in the application of these automatic systems. Indeed experience showed that on large interconnected systems the frequency was controllable to a greater extent than was required by the customer and that interruptions of service resulting from incorrect setting of the tie-line power between interconnected systems were very rare.

An electro-hydraulic governor of high sensitivity (Paper No. 322)[15] provided a focal point for the comments of a number of speakers who emphasised the need for an accurate frequency regulator in large power networks. Briefly, this governor consists of a pilot generator, a frequency measuring circuit with an amplifier and mixer and a hydraulic amplifier to operate the main governor valve through a hydraulic servomotor ; adjustment of the required frequency setting is done by a "Variometer" with a calibrated scale.

Commenting on the question of accuracy in speed regulation Mr. E. B. Powell (London Division, C.E.G.B.) referred to tests that had been made in Great Britain on the response of conventional governor gear ; in many instances it was found that the valve movement was out of step with the causal speed change. Mr. Powell asked whether there were any countries in which electric governors were being fitted. He thought there were excellent reasons for studying the possibilities of all-electric governors as a substitute for centrifugal governors.

Several speakers discussed various aspects of load-frequency control—a subject of considerable interest on the Continent where one finds large electricity supply networks linked by tie lines. In Great Britain the only comparable example of a tie-line line linking two independent national supply systems will be the cross-Channel cable between the networks of the C.E.G.B. and Electricité de France. Mr. K. C. Parton (General Electric Company, Ltd., England) mentioned the possibilities of applying d.c. controlled saturable reactors to act like a "spring" between the two a.c. systems. Such a device would help the two systems to operate with tie-line control without any need for excessive accuracy or for the matching of power/frequency control characteristics of each system.

*Network Transient Operation.*—A number of the eleven papers in this section dealt with the behaviour of synchronous generators under the influence of automatic field regulators.

A development that aroused special interest in the discussion was that of a continuously acting voltage regulator with additional rotor angle control (Paper No. 309).[8] This paper described the performance of a voltage regulator in combination with a special limiter. These two items are designed to function together to provide correct voltage control under normal conditions and give overriding rotor angle control to ensure the stability of the alternator under abnormal conditions. Briefly, the voltage regulator itself is static, the only rotating components being the main d.c. exciter and the small permanent-magnet alternator which is mounted on the shaft to provide the rotor-angle signals.

Several sets of this regulator equipment are in operation in British power stations: there are two at Poole and two at Bold. The latest application is to the six 120MW turbo-alternators which are being installed in Northfleet power station (London) ; the first of these sets has been commissioned and the system of voltage regulation with rotor angle control is reported to be operating satisfactorily. Compared with the original installation at Poole, the Northfleet equipment embodies several improvements in the stability controls to give more rapid response and extra stability margins. It is reported that rotor angles of 135 deg. on full load have been reached at Northfleet without difficulty.

In the discussion of this group of papers Mr. E. B. Powell (C.E.G.B. London) said that rotor angle control was very important in the British supply network ; he wondered whether it would not be better than derivative control of the kind described in Paper No. 315.[12]

The idea expounded in Paper No. 315—the use of feed-back signals proportional to the first and second derivatives of the load angle—was, of course, developed for the Swedish State Power Board and is applicable to power systems having similar characteristics.

A point made by Mr. C. Concordia (U.S.A.) was that the stability of synchronous generating plant in a system area could be raised by a general raising of the voltage in that area—which is, in effect, what the rotor angle limiter does.

Some interesting results of steady-state and transient stability tests on a 30MW steam-driven turbo-alternator in Great Britain were given in Paper No. 104.[1] This paper showed that when full vacuum was maintained the set could be motored from the system, with the stop valve shut, without overheating. Operating as a synchronous condenser, with zero excitation, the generator (equipped with a continuously acting voltage regulator, having a high rate of response) was perfectly stable under both steady-state and transient conditions. In a test when the machine was generating 18 per cent full load a three-phase fault was applied, with a rotor angle of 123 deg. and the machine remained completely stable. An economic appraisal recorded in the paper showed that the 30MW generator set providing reactive power was more economic to operate than a normal synchronous condenser, on the assumption that no additional expenditure would be needed to pay for labour and boiler banking.

Boost regulation on electric power systems in the U.S.S.R. was described in Paper No. 325.[17] In this system a large grid-controlled mercury-arc rectifier is used to give a very strong boost to the alternator field in response to a sensing signal derived from the alternator output. Tests made on the Volga–Lenin–Moscow transmission system, as detailed in the paper, showed impressive results on the stability of the system. For example, when transmitting 540MW along the line a

short circuit on a branch feeder from the 400kV busbars failed to cause instability.

Commenting on this method of boost regulation Mr. K. C. Parton suggested that the equipment appeared to be very expensive ; it included a great deal of intricate equipment for handling input signals from the alternator to the automatic voltage regulator. He claimed that the rotor angle control previously referred to would be capable of giving equally good results if it were equipped with powerful last-stage amplification and endowed with a fast rate of response.

*Self Synchronisation.*—Contributors to the discussion generally agreed that in Great Britain large sets were capable of self-synchronisation without any need to take the load off the alternators.

*Voltage Fluctuations.*—Mr. W. Casson (C.E.G.B. London) described a recent successful experiment on a method of correcting voltage " flicker " on a 500kVA arc furnace. Commenting on this work Mr. K. C. Parton emphasised the ability of fast-acting saturable reactors to prevent flicker—which was very marked because of the heavy sudden unbalanced voltage inherent in the operation of the furnace.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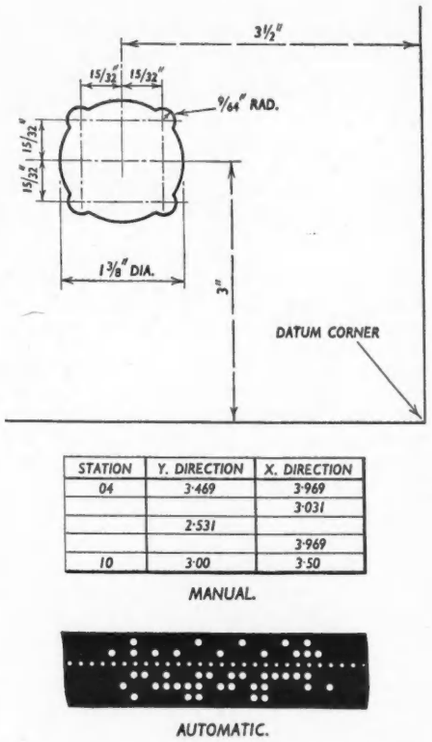


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MANUAL.



AUTOMATIC.

**Fig. 2—Manual and automatic programme instructions for a typical aperture**

# Automatic Control of a Wiedemann Turret Press

*By applying automatic control to a Wiedemann turret press The General Electric Company, Ltd., has effected significant economies in punching out sheet steel panels used in making switchgear cubicles at the company's Witton Works. A programme of instructions is punched on a standard teleprinter tape to initiate impulses which are converted, through telephone relays, into the required movements of the press turret and table.*

A SYSTEM of automatic control has been developed and applied to one of the Wiedemann turret presses used at the Witton Works of The General Electric Company, Ltd., to punch out the sheet steel panels for indoor switchgear cubicles. A typical press is shown in Fig. 3. The panels are punched with a series of standardised apertures corresponding to the instruments, relays and accessories fitted to the switchgear cubicles. For many years presses of this class have been operated manually, and the need for an automatic system of control arose because the operators tired rapidly from the strain of continually watching the scales which indicate the position of the panel relative to the punch.

The automatic control system described below was devised by the control engineering group of the G.E.C. Research Laboratories at Wembley, and was applied to a machine at the Witton Works early in 1959. The new system makes use of teleprinter punched tapes to initiate electrical impulses which are translated into machine movements by means of telephone relays.

The Wiedemann press used to punch the panels has a capacity of 71 tons and is fitted with a turret containing thirty-two punch and die sets of various shapes, together with an air-operated centre punch, making a total of thirty-three stations. Any of these stations can be positioned under the press ram by rotating the turret. The top portion of the turret carries the punches and the lower portion the dies ; each is driven by separate chains from a common shaft and is locked in position by a sliding pin registering with the frame of the press.

The machine table is capable of carrying a plate of maximum size 10ft by 5ft by ¼in between the upper and lower portions of the turret. The table is provided with two movements, one of which moves parallel to the machine axis (Y-direction) and carries the other which moves at 90 deg. to the Y-direction and is labelled X-direction. The plate is attached to the X-direction slide by four clamps, any one of which can be retracted when it approaches the turret, thus allowing the full area of the plate to pass through the turret.

Under manual operation the slides are positioned by two handwheels to which are attached measuring scales marked in increments of $\frac{1}{16}$in which cover the full movement of the slides ; vernier scales enable the required dimensions to be set to $\frac{1}{64}$in. The operator stands on a platform which is attached to the Y-direction slide and hence

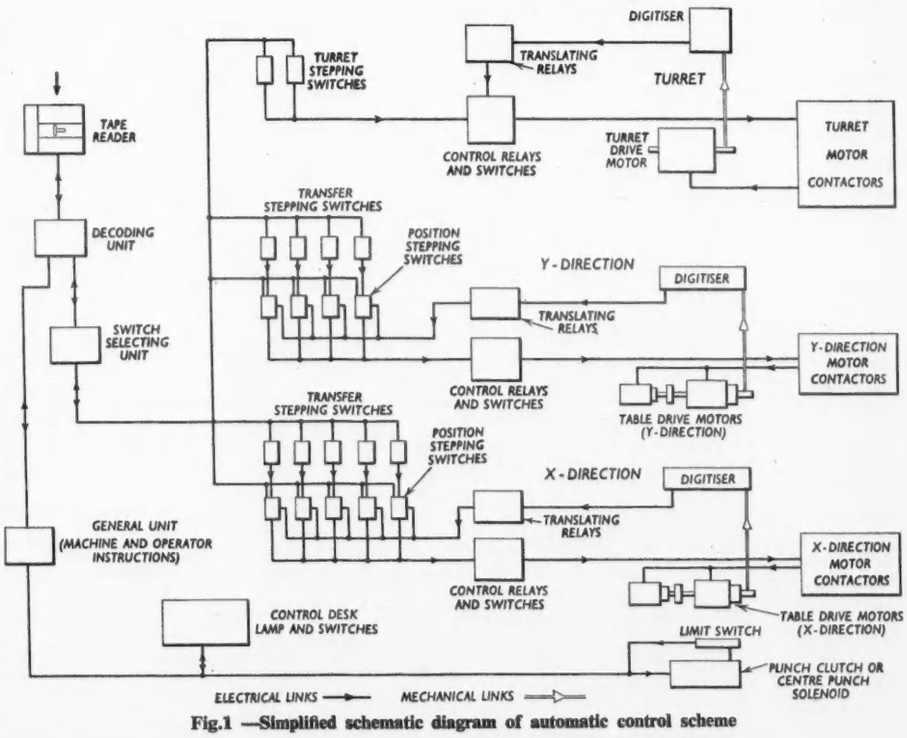



**Fig.1 —Simplified schematic diagram of automatic control scheme**

moves in and out with the component. The handwheels and the push buttons for actuating the ram and the turret are positioned so that they can be operated from this platform. The operator is supplied with a chart showing the station number and the X- and Y-co-ordinates for each punch stroke. This chart is compiled by the programmer, who converts the component drawing into this form (Fig. 2).

*Automatic Control*—For the automatic scheme, punched paper tape (standard five-hole teleprinter-type) was chosen for programming the instructions to the press, and it was decided to use digital control throughout, using the well-tried P.O. type 3000 relay, together with a number of rotary switches. Two small d.c. motors were fitted to drive each table movement, giving three-speed control, and the induction motor driving the turret was replaced by a two-speed d.c. motor. A simplified schematic diagram of the control scheme is shown in Fig. 1.

When the press is under automatic control a tape, carrying the information for punching a complete plate, is run through the tape reader. The perforations are read in discrete phrases, and each phrase is decoded by a set of relays which check the reading and route the information to the appropriate set of rotary switches. There are three sets of rotary switches, one for the turret and one for each of the table movements ; their function is to store the next required movement. When the previous punch stroke has been completed, the three movements take place simultaneously under the control of the rotary switch sets and the associated motor control relays. The actual turret and table positions are fed into the rotary switch sets continuously from digitisers, Fig. 4, whose function is to convert the positions to an electrical code to an accuracy of ±0·01in. As the desired position is approached, the motor speeds are reduced, and when the position signalled by the digitiser coincides with the desired position, the corresponding drive is switched off and a brake applied. When all three movements have finished, a signal actuates the punch. Adequate interlocks and circuits are provided to minimise faulty operation of the system.

*Punched Tape System.*—The tapes are produced on a Creed teleprinter which gives a red visual typewritten record with the punched tape as the by-product. When sub-routines are added or alterations are made to the master tape a Creed transmitter is utilised, the output of which is passed to the teleprinter, which then gives a black-printed record. By this means information added from the teleprinter keyboard is distinguishable from that added by the transmitter, and a changeover from one to the other is very easily carried out.

The information required on the tape for setting the machine and actuating the punch ram consists of a turret movement code followed by two decimal digit codes, a Y-movement code followed by four decimal digits, an X-movement code followed by five decimal digits, and the punch code. Each of these codes occupies one line across the tape and is made up of a combination of up to five holes. These combinations are grouped for easy recognition ; a four-hole combination denotes a movement code, two holes denote a digit code, whilst a combination with an odd number of holes denotes a subsidiary operation such as an operator's instruction. These odd-number combinations are preceded by the letter code. The grouping provides a means of checking the movements and their digits while the tape is being read. The letter code cancels out the checking circuit when an odd-number combination is read. One whole setting occupies 1½in of tape, but for the sake of economy the tape is not repunched unless there is to be a change in movement.

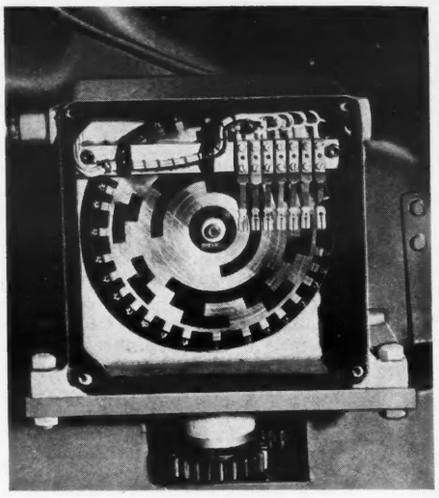


Fig. 4—Turret digitiser mechanism

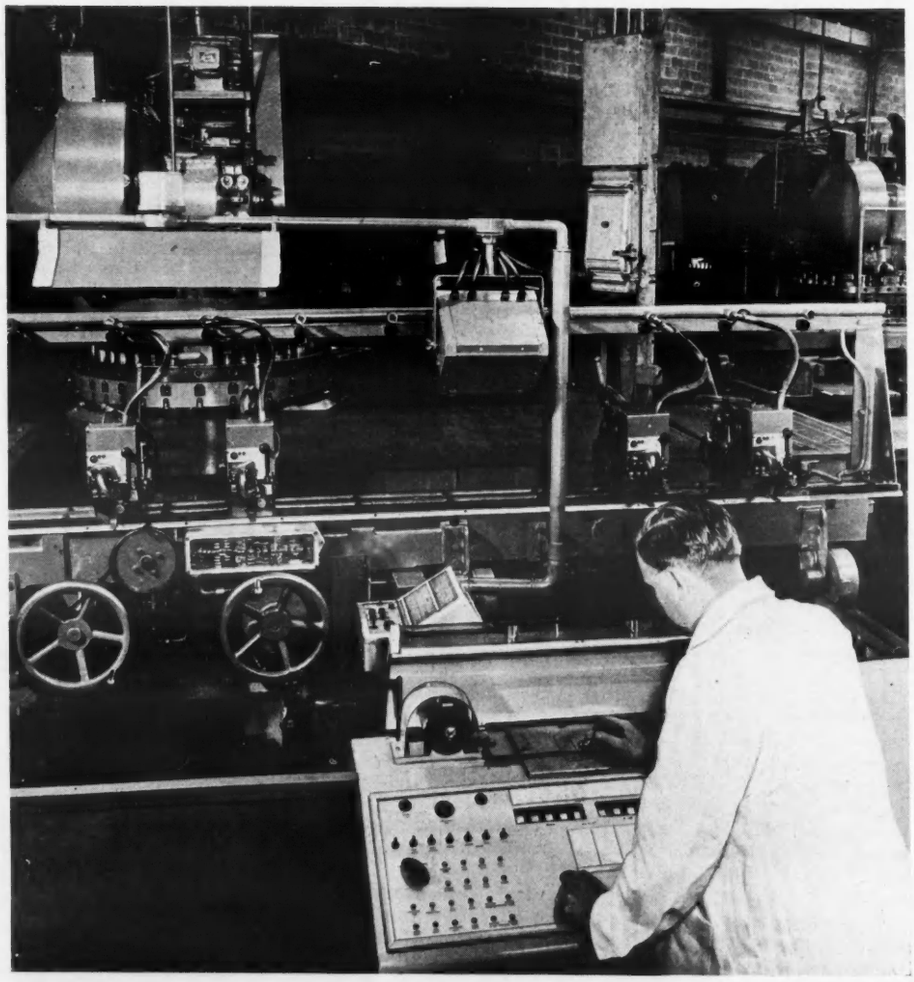


Fig. 3—Wiedemann turret press with automatic control

The panels produced on the press are punched with a standard series of apertures, but the position of these apertures may vary from panel to panel. Time can be saved by programming the punches required to make each aperture, taking the aperture's centre point as the datum, and then adding these individual programmes or sub-routines into a master programme. When sub-routines are added to the master programme in this way they are preceded by subsidiary X and Y co-ordinates which are accepted by the control, and the X or Y co-ordinates which follow are added or subtracted to give the true position. When the aperture has been punched, zero subsidiary co-ordinates are inserted so that any subsequent reading is as programmed. This method can also be used to make small identical components from a single large sheet of metal.

The control system is not able to carry out all the duties formerly performed by the operator, such as removing scrap and moving the clamps along the table. The programme must, therefore, contain coded information to warn the operator that these tasks must be done. At that point the press is stopped automatically and the appropriate indication is given on the control panel.

*Advantages.* — Automatic control has resulted in a direct operational saving of 25 per cent in machine time, and a corresponding overall saving of 33⅓ per cent, as the operator is able to do other work while the machine is in operation. Full output can be achieved, without physical strain, by an unskilled operator after a training period of two or three days. The use of sub-routines by the programmer responsible for compiling the instructions has resulted in a saving in time of 70 per cent and has greatly reduced the mental fatigue associated with the task of compilation.

# International Machine Tool Exhibition—No. I

AT the International Machine Tool Exhibition which opens at Olympia, London, to-morrow, all of the leading British manufacturers and many from the Continent and the United States will be showing the latest designs of their machine tools and ancillary equipment. Once again the international character of this exhibition will provide an unrivalled opportunity to examine the trends in development and compare the products of British firms with those of other machine tool making countries —for over 300 overseas firms are represented upon this occasion. Of the 1350 machines to be exhibited, nearly 800 are British, 250 German and 123 of Swiss manufacture ; whilst the other countries to be represented include the United States, Italy, France, Czechoslovakia, Sweden, Belgium, Denmark, Austria and Poland. Practically every class of machine can be seen under power so that comparisons can be made of various designs, their performances checked and points of particular interest discussed with competing manufacturers. In addition to the machines themselves, much interest attaches to the variety of ancillary equipment, tools, gauges, lubricants, cutting oils and the many other factors which have such an important role in the attainment of efficient production in every workshop.

The machines exhibited will cover the full field from the simple conventional design to the latest high-precision, high-production machines incorporating automatic cycle operation or programme control. In addition there are to be shown several representative designs of transfer machines and unit head assemblies for special purpose work. A point of interest in some of the high production machines will be the developments which have been made to enable rapid retooling and resetting to make possible the economic production of a variety of component sizes in relatively small batches. Probably one of the most noticeable developments in production machine tools since the last exhibition four years ago will be the number of work transfer and feeding devices which have been introduced. These devices, coupled with sizing equipments, have made line production possible with types of machines which only a few years ago would have been considered quite unsuited for in-line arrangement with automatic transfer and feeding.

Although it is natural that machines developed for high production speeds and manufacturing programme control will attract much attention users concerned with one-off and small quantity production will find much interest in the conventional machine tools. It is not infrequently the case, even in mass production factories, to find many operations which can be performed equally well on properly tooled general purpose machines as on the expensive high production machines incorporating special control features which are rarely, if ever, used to their fullest extent. This fact has become more evident with the steady improvements made in recent years to widen the range of feeds and speeds, increase rigidity, and incorporate a higher degree of precision in operation of conventional production machines.

It will be seen that cutting tool manufacturers have not lagged behind the machine tool designer ; not only have improved materials been developed but, particularly in connection with throw-away tips, progress has been made towards reducing the production time losses involved in tool changing operations. There is little evidence that ceramic materials will in the near future replace the carbides for cutting tools, although some interesting examples of high-speed machining using ceramics will be well worth noting. Many interesting gauging and measuring instruments are to be shown and in this direction the speed and accuracy now attainable with standard workshop equipment is particularly noticeable. The other ancillary products to be shown at Olympia include heat-treatment plant, welding equipment, electrical drives and controls, and there will also be a good display of wood-working machines.

### David Brown Company, Ltd.

The gear-making and finishing machines made by the David Brown Machine Tool Division of Manchester include two new high-precision machines incorporating electronic control systems which have been developed in conjunction with the National Engineering Laboratory and E.M.I., Ltd. These machines, the " P.H.30 " gear hobber and the " M.H. 140 " turbine gear hobber, are illustrated in Figs. 1 and 2.

The " P.H.30 " machine is designed to produce gears up to 30in diameter and it incorporates the N.E.L. diffraction grating system to check and control the transmission accuracy of the table drive. For this fully automatic control system a circular diffraction grating having 21,600 radial lines is mounted inside the machine table and another grating with 180 lines on the worm drive shaft. As the ratio of the number of lines on the gratings is the same as the gear ratio between the table and shaft the lines pass given stationary points near each grating at the same frequency. Errors in the transmission of the table drive will cause the lines on one grating to advance or retard compared with the lines on the other. By having a light source on one side of each grating and a reference grating and photo-electric cell on the other, sinusoidal electric signals are derived from each unit when the machine is running. By comparing the phase of these signals, the errors of the table transmission are measured. The error signal is then amplified and utilised in a " feed-back " to impose fine correction to the transmission through a servo-correcting mechanism. The accuracy is thus built into the machine and will never vary due to mechanical wear.

All the electrical equipment for the accuracy control system is enclosed in a small console, which can be set apart from the machine, since it is completely automatic and does not involve the operator. The firm's machines incorporating the N.E.L. control system enable the initial accuracy of the table drive to be maintained throughout the working life of the machine. It is stated that the measuring system has an accuracy of ±1 second of arc, which corresponds to 0·00015in (0·004mm) on a 30in (760mm) diameter gear.

The " Emisyn " control system fitted to the 140in capacity turbine gear hobbing machine is designed to provide a continuous check on indexing accuracy and also to compensate for cumulative errors.

The basic measuring elements of the system are the " Inductosyn " and " Resolver," and their arrangement in the machine can be seen in the diagram Fig. 3. The " Resolver " is a signal generator and is driven by the worm drive shaft which comes from the main gearbox. The " Inductosyn " is mounted in the centre of the table ; it consists of a stator supported by the bed and a rotor which turns with the table. The " Resolver " produces an electrical signal representing the rotation of the worm drive shaft. Through the mechanical drive, this rotation is also transmitted to the table in the form of rotation or a " mechanical signal," but includes errors introduced by the gears and the master worm and worm-wheel. Thus, when the electrical and mechanical signals are compared at the " Inductosyn," the difference represents the errors in

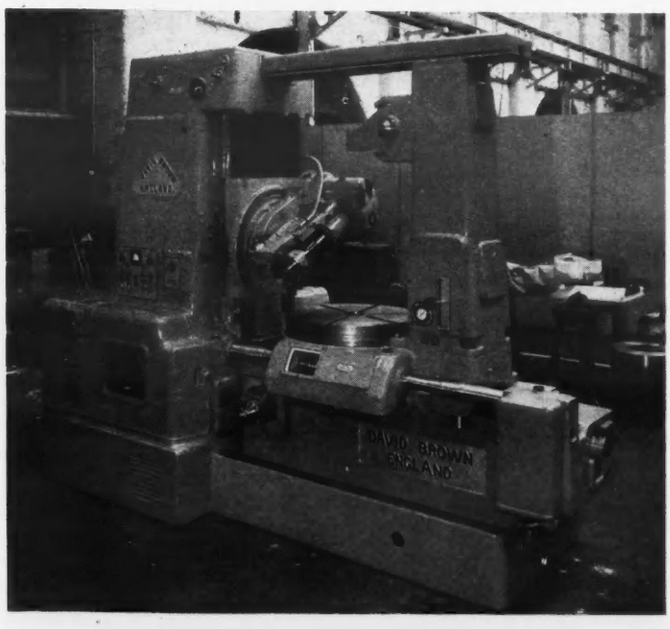



**Fig. 1—Hobbing machine for gears up to 30in diameter, equipped with N.E.L. diffraction grating system for checking and controlling the accuracy of the table drive to within ±1 second of arc—David Brown**

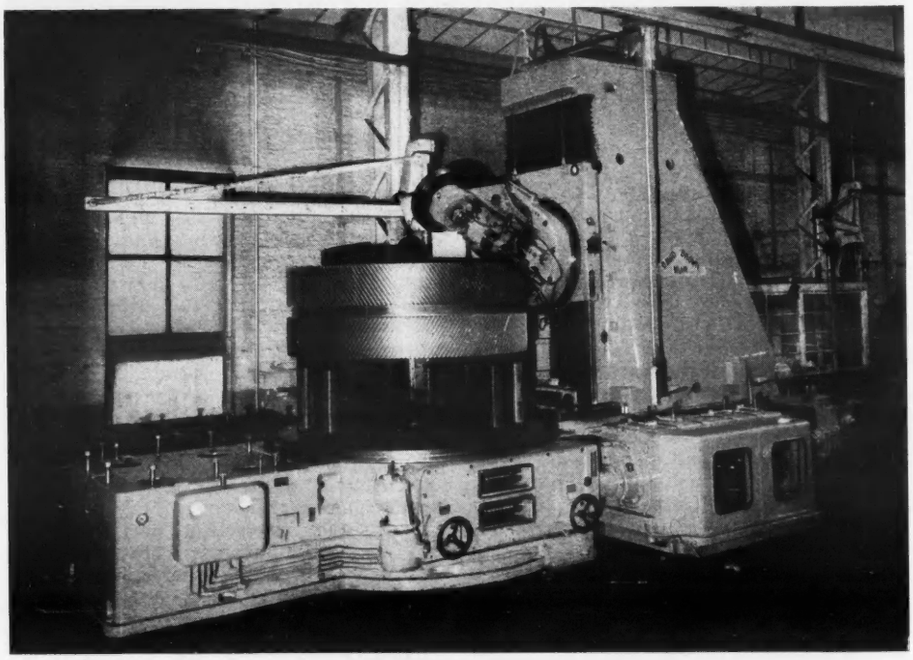


Fig. 2—Turbine gear hobbing machine equipped with the "Emisyn" system of accuracy control—David Brown

the master wheel and other gears in this drive.

The obtaining of a continuous electrical signal of the divide errors of the table drive as the machine is rotating is a very important advance in gear hobbing machine design. In the David Brown machine, this development is taken a stage further, to the point of amplifying the error signal and utilising it to impose fine corrections continuously through a servo-motor and correcting mechanism. Hence the accuracy is built into the machine and will not vary as a result of mechanical wear.

The "Inductosyn" consists of two glass discs providing the rotor and the stator and each of which has a silver pattern on one face. The pattern on the rotor forms a continuous printed circuit coil of 360 radial lines, the two ends of which are connected to the control console through a slip-ring and brush unit. The pattern on the stator has sixteen sections, each consisting of a printed circuit coil of sixteen radial lines. The rotor and the stator, with appropriate wiring, form a 360 pole "Inductosyn."

The correction is imposed on the worm drive by the axial displacement of a helical gear with respect to a mating gear. This axial displacement is derived from a frictionless and backlash-free recirculating ball nut and screw which is driven through a spur gearbox from a 100W servo-motor. There is a very high gear ratio from the servo-motor to the table so that a correction of 0·00025in at the master wheel is obtained by a 0·1in axial displacement of the helical gear or eighty revolutions of the servo-motor.

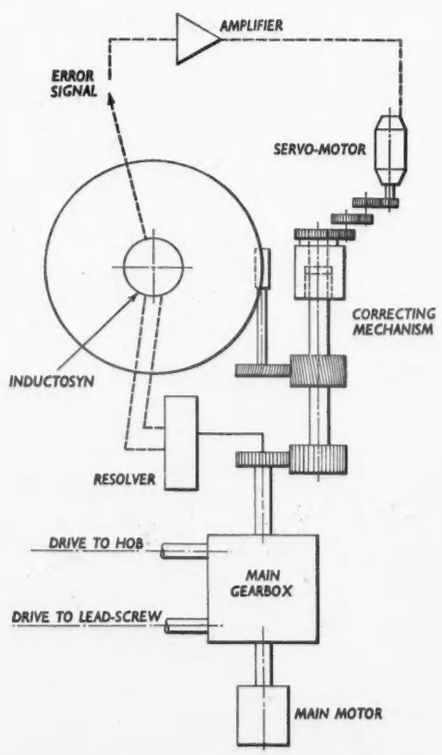



Fig. 3—"Emisyn" system for measuring and controlling the accuracy of precision gear hobbing machines—David Brown

The accuracy of a machine fitted with this equipment is no longer entirely dependent on the accuracy of the master worm-wheel, but is derived from the "Inductosyn," the maximum accumulative error of which is better than ±2 seconds of arc. The value corresponds to a maximum of 0·0009in at the 95½in master wheel diameter of a 3·5m machine—the British Standard Grade "A" allowance (maximum accumulative) for this size of machine being 0·0026in.

One of this firm's "Hydrax" production gear hobbing machines will be exhibited in-line with a gear shaving machine. Both of these machines are equipped for automatic work loading.

### H. W. Ward and Co., Ltd.

The turret lathes and capstans shown by H. W. Ward and Co., Ltd., Selley Oak, Birmingham, will be tooled up for producing typical components. The machines will include two No. 7 turret lathes, one of which departs from the standard 2½ bar capacity in that its spindle has a 4⅝in bore. This machine will be equipped for internal and external threading sample tubes to demonstrate high-speed screwing using tungsten-carbide tools. The standard No. 7 turret lathe has eight spindle speeds which are available in three ranges—from 26 to 536 r.p.m. for heavy duty; 37 to 750 r.p.m. for normal work; and 50 to 1000 r.p.m. for high-speed production. Ten rates of feed are available for the intermediate saddle, which also has full sliding, surfacing and screwcutting motions. The hexagon turret also has ten feed rates and means of quick power traverse.

The other No. 7 machine is of the firm's "Prelector" design with hydraulic actuation of gear changing enabling the preselection through two dials of all speeds and direction of rotation. This machine, illustrated in Fig. 4, will be fitted with a hydraulic copy turning attachment and engaged in machining a steel axle shaft. The largest turret lathe made by the firm is the No. 16, which has a spindle bore of 8½in and swings 35in over the bed covers. One of these machines on show will be fitted with a 32in four-jaw chuck holding a large steel billet, and will demonstrate heavy-duty turning using tungsten-carbide tools.

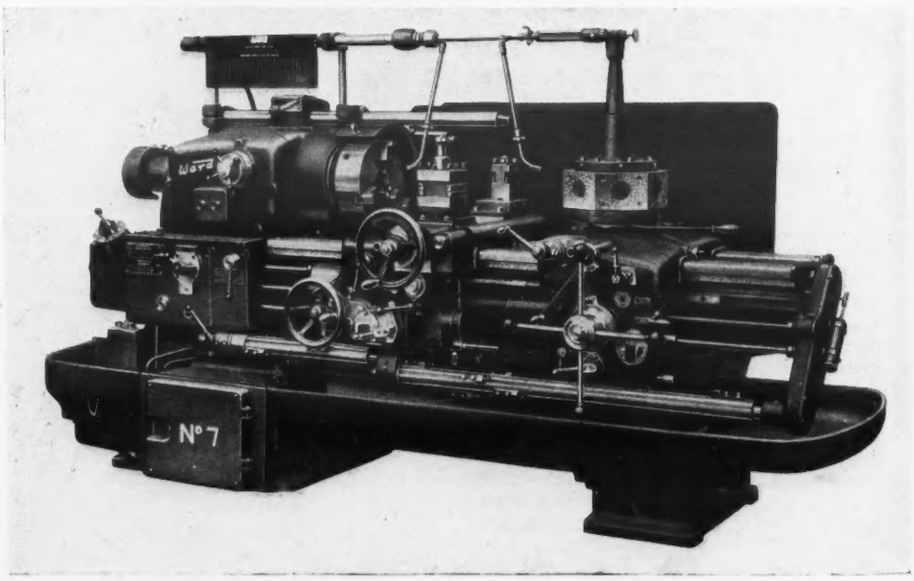



Fig. 4—No. 7 "Prelector" turret lathe—Ward

### Kerry's (Great Britain), Ltd.

A drilling machine made by Kerry's (Engineering), Ltd., Warton Road, London, E.15, with a capacity of $\frac{7}{8}$in in mild steel and a stroke of 5in, is available with either manual or automatic power feed with three cutting rates of 0·002in, 0·004in and 0·008in per revolution. The drill head, which is adjustable over a distance of 9½in on the column, is driven by a 1 h.p. motor. Power is transmitted through a two-speed constant mesh gearbox, vee-belts and variable pitch pulleys to the spindle which has a speed range of 57 to 4000 r.p.m. Spindle speed changes are made through a cranked handle with reference to a dial showing fifty-eight indicated speeds. When fitted, drive to the automatic power feed is taken through worm gearing and multi-tooth clutch plates and a knock-off trip provided can be set to disengage the feed and automatically return the spindle. The machine also incorporates a built-in coolant supply and low voltage lighting with a spotlight fitted under the head to illuminate the working area.

A new $^{11}/_{13}$in swing lathe of this firm is designed on clean modern lines with an enclosed cabinet base. Its all-geared headstock is driven by a 2 h.p. motor and gives twelve spindle speeds from 40 to 2000 r.p.m. A Norton feedbox gives fifty-five pitches from 4 to 448 threads per inch and the seven power feeds range on geometrical progression from 0·0004in to 0·028in per revolution. Henry Broadbent, Ltd., a member firm of the Kerry group, will show one of its 10ft boring and turning mills and an 18in swing lathe. The boring mill can be driven by a 30 h.p. or a 40 h.p. motor with transmission to the table through a twelve-speed gearbox. Its cross-slide can be supplied with two rams or, if required, a pentagon turret on the right-hand side. Also to be shown are ultrasonic drilling and cleaning equipment made by Kerry's (Ultrasonics), Ltd.

### Churchill Machine Tool Company, Ltd.

The five precision grinding machines on the stand of the Churchill Machine Tool Company, Ltd., Broadheath, Manchester, will include the new design of heavy-duty traversing wheelhead roll grinding machine shown in Fig. 5. It is a 32in by 192in machine from a series with capacities ranging from 42in diameter to 62in diameter, the length capacity of the latter machine, which weighs 137 tons, being 360in.

As can be seen in the illustration the machine has a bed built in two sections, one section taking the traversing wheelhead carriage incorporating the grinding wheelhead, wheel feed mechanism and traverse gearbox with the electrical controls, &c. The other bed section of deep box construction carries the work supporting and driving assembly and is rigidly bolted along its entire length to the wheelhead carriage bed. Whilst the machine is in operation the slideways of the wheelhead bed are automatically lubricated from a pump housed in the wheelhead carriage. Pressure switches in the oil feed lines ensure the slides are lubricated during operation, and should the lubricating system fail, the carriage stops automatically. Permanent flexible covers protect the slideways for their full length. The operator's platform is mounted on the traversing wheelhead carriage and from it he has complete control of all movements of the machine.

The grinding wheelhead carrying a 36in diameter wheel, is designed to give the utmost rigidity to the bearings, and is fitted with a large diameter "Nitralloy" spindle driven by a 40 h.p. variable speed motor. The bearings are of the cone adjusted design with constant lubrication, pressure switches being provided in the pipeline to prevent the spindle being started until the oil is circulating. The feed to the wheel, which is applied both automatically and by hand, is through worm reduction gearing to a large diameter screw and nut. The feed wheel being graduated to read 0·000125in.

The machine is fitted with the maker's automatic electronic feed by means of which the maximum use is made of the power available at the grinding wheel. This feature, apart from being a valuable time-saver, requires less operating skill to keep the grinding wheel cutting at a steady rate, and with it the power absorbed by the grinding wheel is kept virtually constant. With this form of operation the wheel feed is applied by hand until the load has been picked up and the wheel traversed along the roll face. As the mechanical load on the grinding wheel motor falls, due to the material removed, a corresponding reduction in the motor armature current takes place. The automatic feed mechanism is designed to ensure that a feed is applied immediately a fall in current takes place, and the operator can set the load regulator to any value of load current within the capacity of the grinding wheel motor.

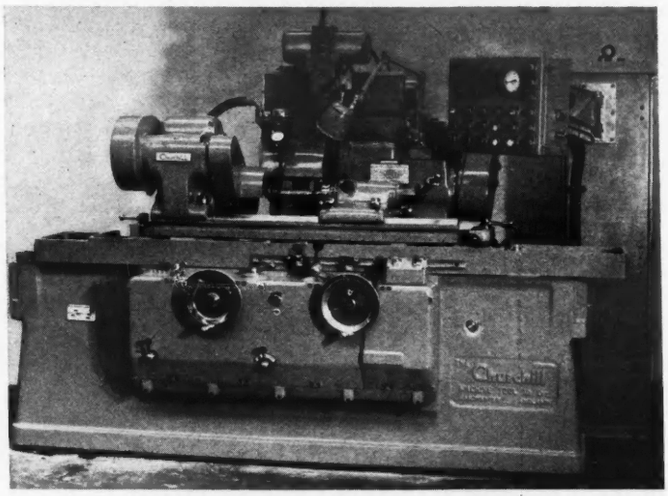


**Fig. 6—Plain grinding machine fitted with diminishing feed mechanism, an automatic wheel truing and compensation equipment, and having an automatic grinding cycle using an electric sizing gauge for plunge grinding operations —Churchill**

At its front end the wheelhead base is mounted on roller bearing trunnions on the carriage, and at the rear it is carried on the cam lever of a cambering, or crowning, mechanism which produces both convex and concave cambers. A fixed angle camber bar extending the length of the machine and bolted to the wheelhead body has a slot in which a slipper moves as the wheelhead carriage traverses the length of the roll body. As the slipper moves up or down the inclined slot, the arm carrying the slipper imparts a rotary movement to the bracket on which a cam is mounted. As the cam moves through its arc, a lift is imparted to the camber lever which is fitted with an adjustable fulcrum roller to increase the camber as required. This upward movement is transferred to the trunnion-mounted wheel head base, and so the grinding wheel is moved towards or away from the roll body and produces the form of camber required.

The workhead is driven by a 15 h.p. variable speed d.c. motor through vee belts. Electrically interlocked power adjustment of the head along the bed is effected by motor and worm reduction gear. The controls which are all operated from the wheelhead carriage platform are also duplicated on the workhead for use when setting up the roll, means of hand adjustment also being provided. Speed adjustments are carried out by push buttons and the actual speeds can be read on tachometer indicators whilst

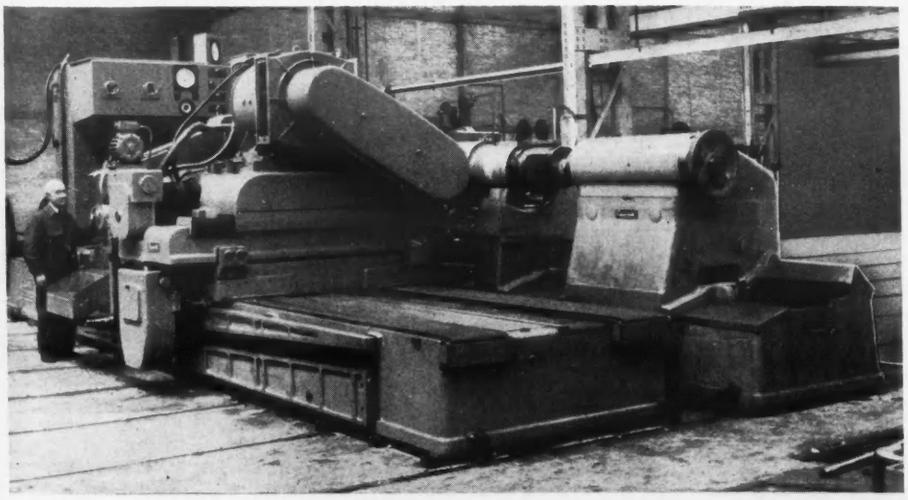
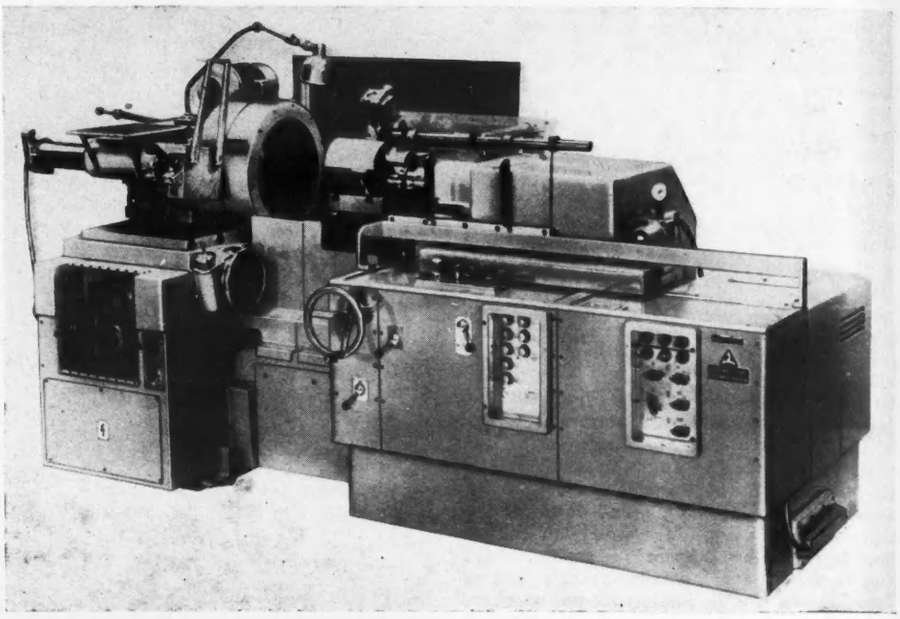
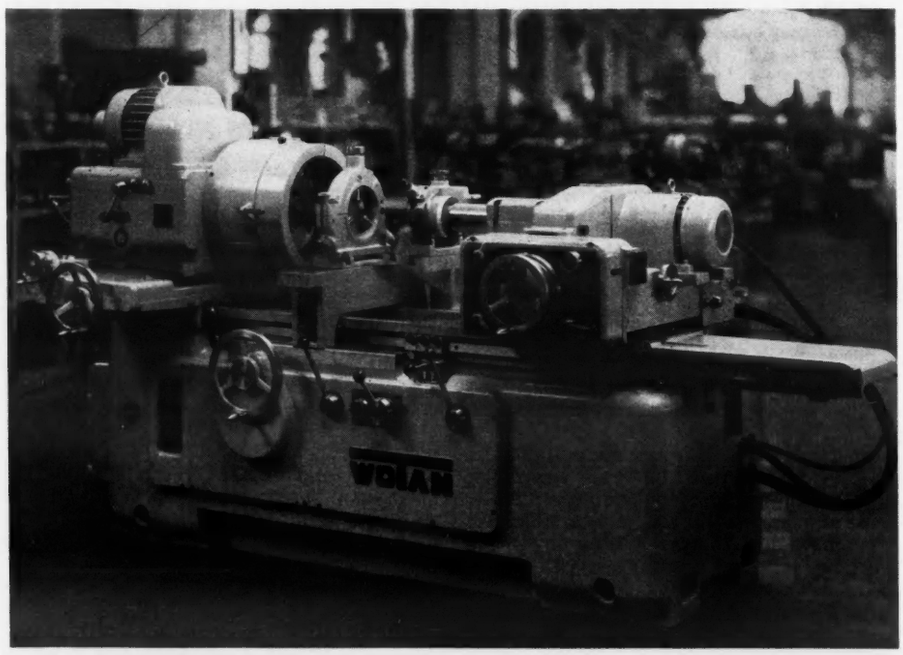


**Fig. 5—Heavy-duty roll-grinding machine with automatic electronic feed—Churchill**

# Internal Grinding Machines

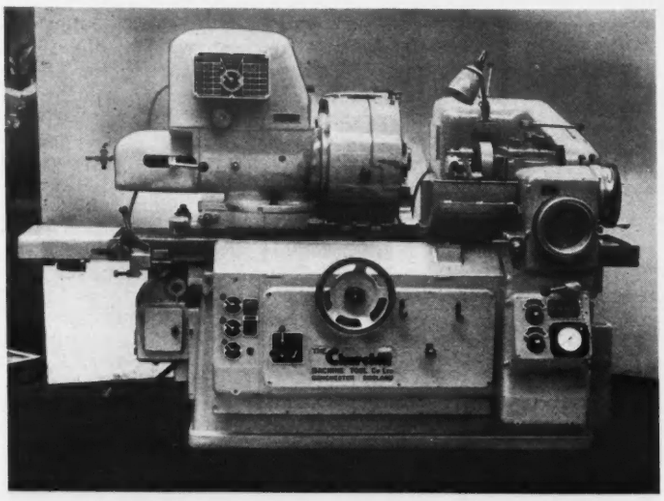
Of the four designs of internal grinding machines we illustrate, two are of British and two of Continental manufacture. The Kamenicek semi-automatic machine on the RIGHT (to be seen on the stand of the Selson Machine Tool Company, Ltd.) is for heavy-duty work up to 25in diameter. It is hydraulically operated with an electrically-controlled automatic work cycle. Three control means incorporated can be used individually or in combination and they include a cam which determines final work size with reference to the position of the dressing diamond, a step gauge and an impulse gauge with two styli. The Wotan machine BELOW (Soag Machine Tools, Ltd.) grinds bores up to 20in diameter and 20in deep. It has a cross-travelling workhead which can be swivelled 90 deg. so that bores, outside diameters, faces and tapers can be ground in one setting using the internal spindle.

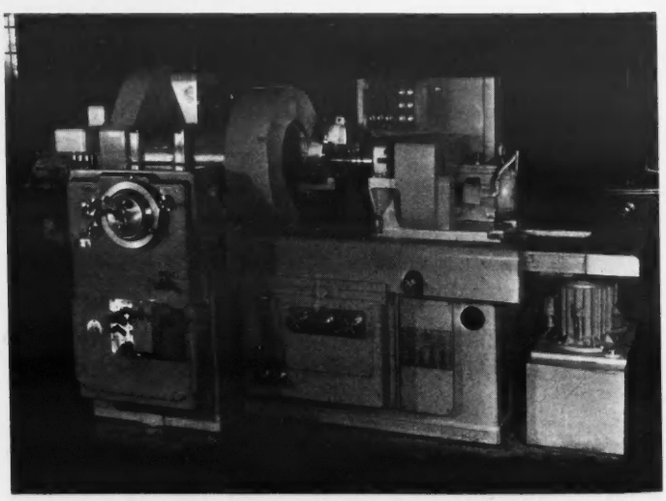





Of the two automatic sizing internal grinders illustrated BELOW that on the LEFT made by the Churchill Machine Tool Company, Ltd., swings work up to 12in inside the water guard and 19in over the table. It can be operated on a single automatic cycle for plunge grinding and, in addition, on a double automatic cycle with intermediate truing for either traverse or plunge grinding. In each case sizing is controlled by the setting of the diamond. In addition, the machine is fitted with an automatic plug gauging device using a solid plug gauge carried on the end of a push-rod sliding in the bore of the workhead spindle.

The heavy-duty machine on the RIGHT BELOW is made by Keighley Grinders (Machine Tools), Ltd., and grinds holes from $\frac{1}{4}$in to 6in diameter to a maximum depth of 6in. It incorporates a hydraulically-operated double-gauge sizing system to establish accurate and automatic control of bore diameter. A wheel dresser operates between the roughing and finish grinds and wheel wear compensation is automatically applied at the termination of each complete grinding cycle.





these adjustments are made to the wheel, work and traverse speeds.

The tailstock of heavy box section design has its top portion carrying the centre adjustable for alignment correction, and it has means of power and hand traverse similar to the workhead. Journal rests having wide supports on the work bed are fitted with white metal lined pads on which the roll rotates. These rests are adjustable over a wide range of diameters and are provided with hand racking.

The 10in by 20in plain grinding machine illustrated in Fig. 6, is fitted with the maker's diminishing feed mechanism, automatic wheel truing and compensation and automatic control of the grinding cycle by an electric sizing gauge for plunge grinding operations. With these facilities after the machine has been set up for grinding the first component and a decision made as to the number of components which can be ground at one wheel truing, the grinding, truing and compensation cycles are automatically carried out. In the operating sequence when the machine has completed a pre-selected number of cycles the wheel is automatically trued. In the grinding operation after truing the first component will be oversize initially, and the automatic compensation mechanism comes into effect. For this compensation the ratchet in-feed is applied in small increments at timed intervals until the electric sizing gauge indicates that component dimensions are correct. The wheelhead then retracts automatically to its rear position for the loading of the second component in this batch, and grinding cycles can be repeated until the pre-selected number of components has been ground to correct size. At this point the whole cycle of automatic truing and compensation is repeated prior to the commencement of the subsequent batch of components.

**Drummond-Asquith, Ltd.**

In addition to a widely representative selection of machine tools of British and foreign manufacture on the stands of Drummond-Asquith, Ltd., there will be a fourteen-station in-line transfer machine for operations on Austin cylinder blocks and a four-machine gear-making line. An impression of the transfer machine, which is about 65ft long, can be obtained from the photograph we reproduce (Fig. 7). Amongst other operations the line carries out the semi-finish and finish boring of the crankshaft and camshaft bores, facing each side of the central crankshaft bearing and reaming the crankshaft and camshaft bores. At the eighth station a split liner bush is aligned automatically and pressed into one end of the camshaft bore and this bush is fine-bored in position at the next station. After this operation, the block is turned through 90 deg. and there are three successive stations which carry out a series of operations on the distributor bore.

At the entry end of the line an air-operated travelling carriage picks up a cylinder block from a roller track and transports it to the transfer bar and lowers it into engagement with two locators which enter the centre pair of cylinder bores. The transfer bar is then indexed to bring the block to the second station. The bridge-type fixture which can be seen in the general illustration of the machine is typical of the others provided, and the locating and clamping arrangements are common to all stations. Horizontal guide rails on either side of the transfer bar are interrupted to receive two vertically moving jacks which are raised and lowered hydraulically so that when the transfer bar is moving a cylinder block into position the jacks are level with the guide rails. After the transfer bar has completed its movement, the jacks raise the cylinder block from the locators on the bar and thrust it against the underside of the bridge fixture. The final alignment is determined by two vertical plungers which are advanced by the two oil cylinders on the top of the bridge fixture. These plungers enter ½in diameter reamed holes in the sump face of the block.

Swarf is carried from the machine by endless chain conveyor, the drive unit for which can be seen in the right foreground of the illustration. The main control console, from which all movements of the machine can be initiated, incorporates a simple fault-finding arrangement of lights which indicate " heads back," " jacks up," " jacks down," " locators in " and " locators out."

On the linked gear line there is handled a large cluster gear which has already been broached in the bore and had the large gear faced and turned. The line consists of four standard Drummond machines—a "Maxi-rapid " and a " Maximinor " multi-tool lathe, a " Maxicut " gear shaping machine and a " Hoblique " gear hobbing machine—all fitted with automatic work loaders and linked by conveyors.

The Blackburn contour milling and die-sinking machine shown in Fig. 8 is the first all-British horizontal-spindle tracer-controlled milling machine of its kind. It can be made in a number of sizes with from 54in to 120in horizontal travel and 42in to 54in vertical travel, and having a standard transverse stroke of 18in. The heavy base casting has prismatic slideways and the knee assembly is balanced by hydraulic cylinders on the column which travels along these slideways. The knee incorporates large quill box slides and horizontal movements of the quill are effected by hand. A nickel chrome spindle runs in pre-loaded taper bearings and is driven through a twelve-speed gearbox by a flange-mounted motor.

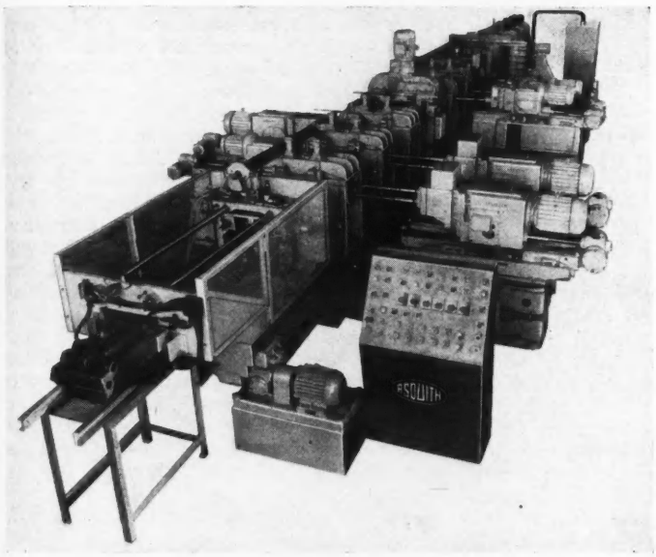


Fig. 7—(Above) Fourteen-station in-line transfer machine for operations on a motor-car cylinder-block. The main control console from which all motions are inititated incorporates fault-finding indicator lights—Drummond-Asquith

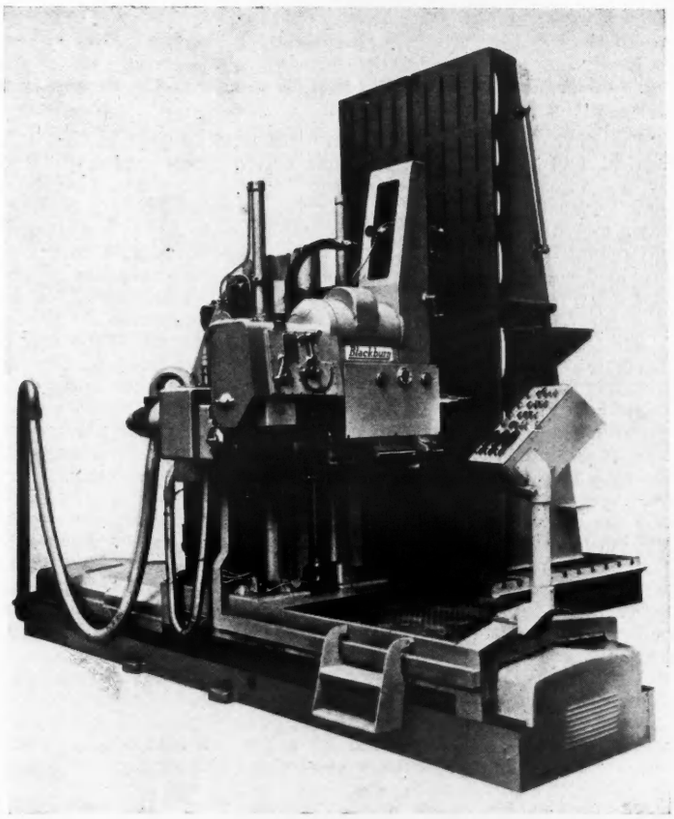


Fig. 8—(Right) Horizontal-spindle copy milling machine made in a range of sizes having a horizontal travel from 54in to 120in and a vertical travel from 42in to 54in. The standard transverse stroke is 18in for all sizes of machine —Drummond-Asquith

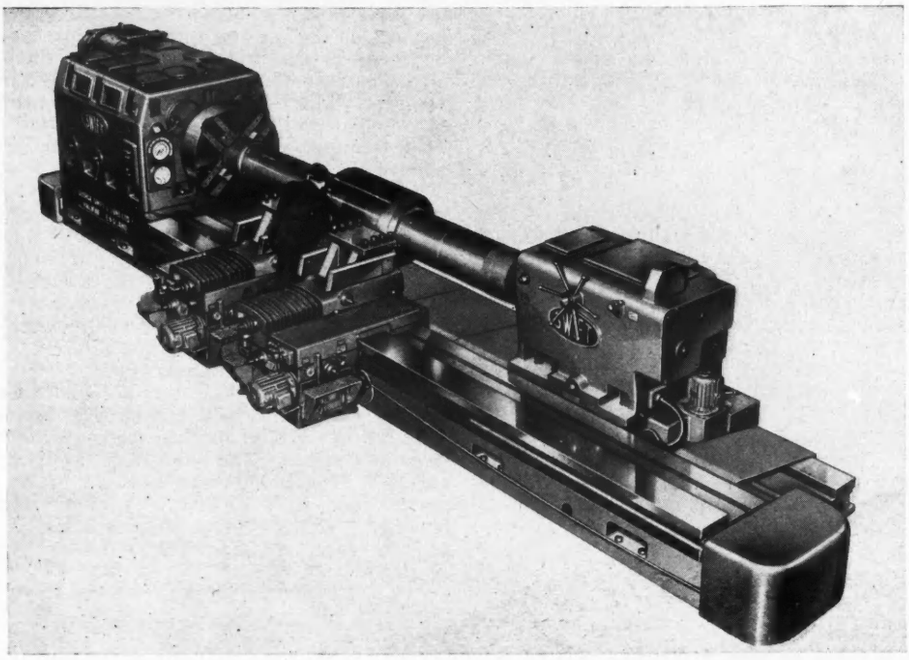


**Fig. 9—Swift heavy-duty roll turning lathe for work up to 42in diameter by 18ft long—Drummond-Asquith**

The three feed boxes for the horizontal, vertical and infeed movements are driven by electric motors controlled by the "Varimag" system, and they in turn drive the gears together with the appropriate electrically-operated clutches. The gearboxes are provided with electro-magnetic couplings so that a high or low speed feed range can be selected from the operator's desk.

The tracer head works on the established principle of opening and closing points which, in turn, operate clutches in the appropriate feed gearboxes. An additional tracer mounting can be supplied together with a column-mounted template holder, to allow the two-template method of tracing to be used. Automatic spindle horsepower setting can be provided with automatic cut-out and cut-in of feeds which can be pre-set by the operator to suit the cutter in use. Work-carrying angle plates are supplied to suit requirements, and the work tables can also be supplied in accordance with the class of work.

Amongst the radial drilling machines to be shown is a new 8ft radius machine in which the hand-operated speed and feed change lever system is replaced by a pre-selector unit. This pre-selector system can be provided for Asquith machines with twelve or eighteen speeds and six or nine feed rates. The selector dials for the equipment are so arranged that all speeds and feeds available on the machine are always visible, the speed and feed at which the machine is set being illuminated, and the pre-selected speed and feed framed in an aperture. Upon operation of the gear change the illuminated indication also changes to match the new speed and feed. To effect change of speed or feed, or both, a push button conveniently situated in the centre of the speed change dial is depressed.

Another new Asquith machine is a 3in spindle, horizontal boring, milling and drilling machine, which has a spindle traverse of 24in and a maximum distance of 30in between the top of the 28in by 44in table and the spindle centre. The spindle drive is taken from a constant speed reversing 10 h.p. motor on the headstock, which drives through gearing providing twelve speed changes. Feed for all motions is derived from a change gearbox in the base of the machine giving eighteen rates of feed either in terms of inches per minute or inches per revolution of the spindle for milling or boring respectively. Quick power traverse and micro setting rates to all movements are also derived from the same gearbox. Feed to the spindle is applied by gearing in the headstock to a rack quill connected to the rear end of the spindle. An automatic feed depth trip is provided on the front of the headstock with an adjustable dial and trip mechanism to set feed depths up to 6in.

One of the two heavy-duty lathes on the Drummond-Asquith stand will be the roll turning machine made by George Swift and Sons, Ltd., for work up to 42in diameter and 18ft long, shown in Fig. 9. It is driven by a variable speed 150 h.p. motor, and with two speed changes available in the headstock there is a steplessly variable range of spindle speeds from 1 to 20 r.p.m. Each of the two saddles is driven by a 3 h.p. motor through a P.I.V. gear unit giving stepless sliding and surfacing feeds. The headstock is fitted with a 46in chuck and the tailstock, traversed by a 3 h.p. motor, with a 36in chuck. The second Swift machine is a sliding, surfacing and screwcutting lathe with a 33in swing and taking 7ft 9in between centres.

A Jungenthal vertical turning and boring mill with a turning diameter capacity up to 39in to be shown can be supplied with a turret head which swivels automatically under push-button control or arranged for programme control under which indexing of the head takes place automatically. Each turret station has a number of control points so that all functions of the machine, such as speed, feed, direction and quick traverse, can be selected anew at each point and a total of sixty points is available over the four turret stations.

A machine introduced by Waldrich-Coburg for heavy planing with medium duty milling operations is generally similar to that firm's standard planing machines, except that it has been considerably strengthened and its cross beam extended to take two planing tool-boxes and a milling head which cover the full working width. The milling spindle is carried in a slide on the head to impart full rigidity in working and it has a vertical traverse of 2ft. This arrangement of planing tools and a milling head combined with a hydraulically-operated table enables a combination of machining operations on large components without loss of time in resetting work.

A Warner and Swasey turret lathe, which swings 16¼in over the bed and engaged in turning brass couplings, will be using the "Elecro-Cycle" control drum by which spindle starting, stopping, reversing and speed are automatically selected as required. These spindle functions are determined during initial setting of the machine and thereafter are automatically engaged during its operation. The turret of the machine also indexes automatically on the return stroke, and it can be back-indexed or skip-indexed as required, by hand. Another Warner and Swasey machine to be shown is a No. 4 ram type turret lathe with an 18½in swing. On this lathe spindle speed changes under lever control are effected through direct-acting hydraulic clutches and a constant-mesh gear train.

The Warner Swasey-Asquith single-spindle chucking automatic shown in Fig. 10 can be supplied with a 10in or 12in chuck and is designed to turn, face, drill, bore, thread, &c., components in long or short runs. Its front and rear cross slides feed tools at 90 deg. to the spindle and the five-station main tool slide feeds tools parallel to the spindle axis. The pentagon turret and cross slides can function in various combinations with each other, and all machine functions relating to component requirements (speeds, feeds, cut-

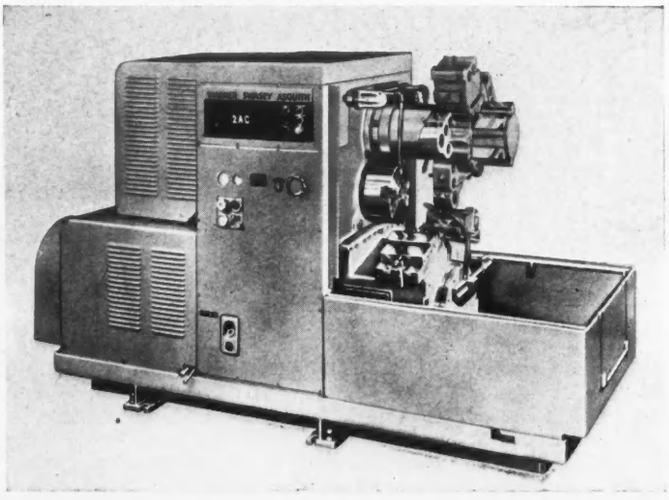


**Fig. 10—Single-spindle chucking automatic—Drummond-Asquith**

ting stroke lengths, dwell, &c.) which are controlled electrically are selected automatically by adjustable trips. A pentagonal control drum equipped with adjustable trips selects feeds, spindle speeds and length of cutting stroke whilst permanent cams are used for both the turret and cross slides.

### W. E. Sykes, Ltd.

A new design of vertical gear generator known as the "V10B" introduced by W. E. Sykes, Ltd., Staines, Middlesex, has a stroke of up to 2½in and takes blanks for external gears up to 10½in diameter and internal gears up to 5in. This machine, shown in Fig. 11, can be supplied in various forms to suit particular components and a semi-automatic model is exhibited. The machine has an adjustable work saddle to provide angular relief and enable the use of maximum radial feeds.

Infeed of the work is operated hydraulically, independent of work rotation, and variable infeeds, between 0·0005in and 0·004in per stroke of the cutter, are quickly set by rotating the disc of a special hydraulic control piston. The hydraulic infeed mechanism does not depend on flow control valves and the infeed rate remains constant irrespective of system or ambient temperature fluctuations. Rapid approach and withdrawal of the work takes place automatically at the commencement and end of each cycle and the final cut is taken with the saddle hydraulically loaded against a dead stop. One-, two- or three-cut infeed cycles are selected by a switch setting and the depth for each cut is set by adjustment of trip rods, which actuate limit switches. To enable precise adjustment of the required tripping distance to be accurately controlled blue pilot lamps on the control panel are illuminated to indicate the exact moment when each switch trips.

Withdrawal of the saddle can be adjusted as required to facilitate unloading of the component being cut. The final cut, which normally takes a full 360 deg. rotation of the blank, can be modified with a plus or minus correction by adjustment of the dial of a "drop-off" indicator on the left-hand side of the machine.

Cutter speeds from eighty to 720 strokes a minute and rotary feeds from 0·003in to 0·021in are infinitely variable through two separate "Kopp" variator units; no changing of pulleys or gears is necessary. With the cutting speed and length of stroke known the setting for the correct cutting speed is obtained from a dial on the right of the machine. Similarly, with the cutter diameter and the radial feed required known, the feed variator setting is obtained by setting the known values on a second lower dial—no calculations are necessary and changes of speed or feed can be made whilst the work is progressing to obtain optimum conditions.

The forward and reverse feeds are selected by switches on the control panel and are controlled by magnetic clutches. In conjunction with a cutter and work truing motor, available as optional equipment, the magnetic clutches are used to provide semi- or fully automatic cycling for segment gears or rack cutting.

In the semi-automatic machine the workholding unit and tailstock are operated hydraulically and after the operator has placed the component on the chuck and depressed the start button the entire cycle is automatic in the following sequence: Tailstock moves down to clamp, work chuck expands and the cutting cycle starts; assuming a two cycle, the saddle then moves forward, initially at rapid traverse speed, and changing over to feed as the work approaches the cutter; first, infeed is stopped at the roughing depth and the gear rotates one turn; the saddle then infeeds to the dead stop and the second cut is made; when the cycle is complete the cutter motor stops, the saddle moves back, the tailstock withdraws and the chuck unclamps.

Amongst the other machines shown by this firm is a horizontal gear generator equipped with an automatic cycle and tooled up to produce two different involute splines simultaneously. The component for this demonstration is an 18¼in long 2¼in diameter shaft. On this shaft there are cut, simultaneously, an end spline (sixteen teeth 8/16 D.P. by 2¼in face width) and a central spline (twenty-two teeth 10/20 D.P. by 3in face width) in a production time of 8¾ minutes.

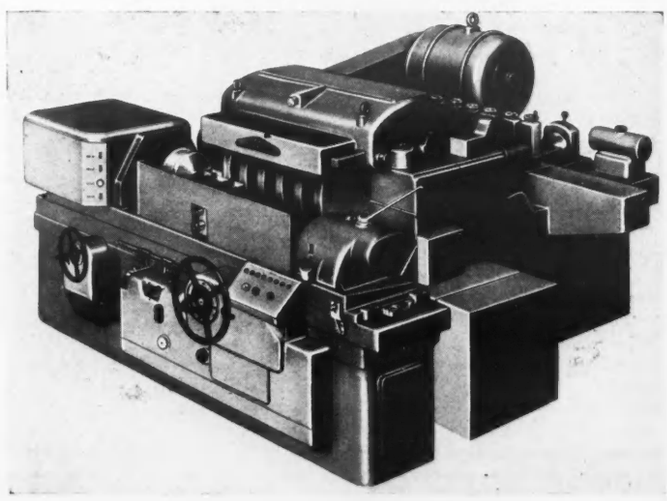
### Newall Engineering Company, Ltd.

We have from time to time described and illustrated the jig boring machines equipped for automatic control which are made by Newall Engineering Company, Ltd., Peterborough, and five models of these interesting machines are to be shown at Olympia. On page 1050 there can be seen illustrated the "Spacematic" Model 2657 machine incorporating the B.T.H. measuring and control system which is stated to be capable of detecting errors in table position to 0·00002in. The scope of this machine can be further widened by the fitting of equipment for high accuracy, two-dimensional, tracer-controlled copy milling, automatic stair-case milling and with an auxiliary horizontal workspindle. Where automatic selection of three ordinates is required the control system can be applied to the movement of the quill in addition to that of the table and cross-slide. The firm's "1520" jig boring and milling machine is fitted with either the Newall roller or optical system enabling table settings to 0·00005in to be made, the machine is equipped also with the "Airmec" automatic measuring and control system which gives greatly improved production times when an overall accuracy of 0·0005in is adequate. Thus the machine has the dual role of catering for high accuracy jigs and components by using the manual setting system and for increased productivity in the more numerous cases where a slightly lower accuracy can be tolerated.

An interesting selection of Newall-Keighley grinding machines will include representa-

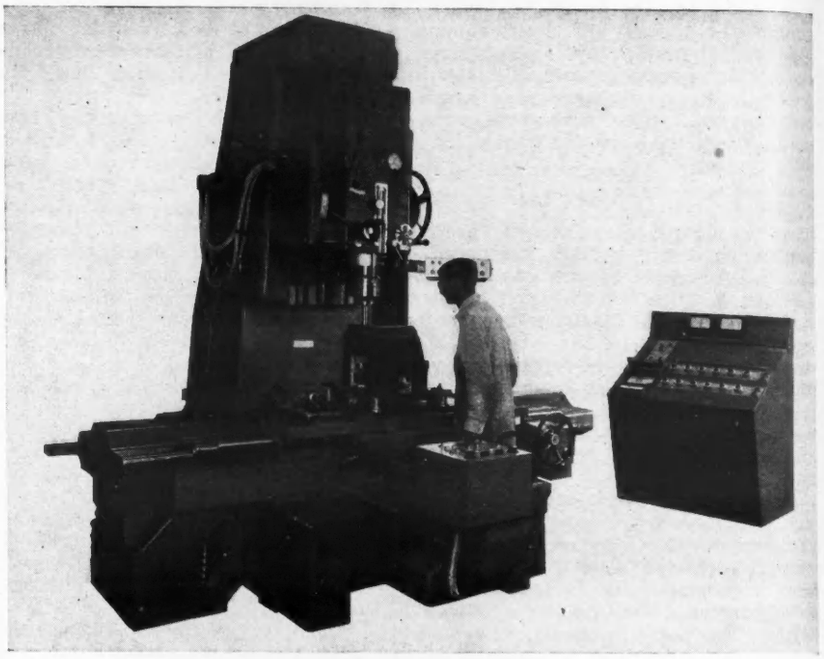
**Fig. 11—(Left) Vertical semi-automatic gear generating machine with a stroke of up to 2½in and taking blanks for external gears up to 10½in diameter or for internal gears up to 5in diameter—Sykes**

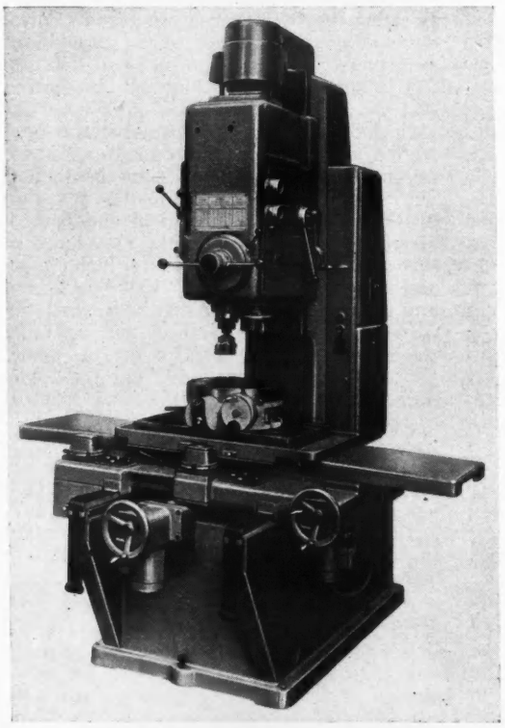
**Fig. 12—(Below) Multi-wheel grinding machine with 12in swing and 40in centres—Newall**



# Jig Boring Machines

Some interesting developments for automatic co-ordinate setting on jig boring machines have been introduced and on the RIGHT we illustrate the "Spacematic 2657" machine of the Newall Engineering Company, Ltd., which has been specifically designed for automatic control with the A.E.I. system. This system, which is capable of detecting errors in position to an accuracy of 0·00002in, provides for selection of co-ordinates by setting dials or by the use of punched cards on the control cabinet. It can also be equipped for two-dimensional tracer-controlled copy milling and automatic staircase milling operations. For application where automatic selection of three ordinates is advantageous the control system can be applied to movements of the quill in addition to those of the table and cross-slide.

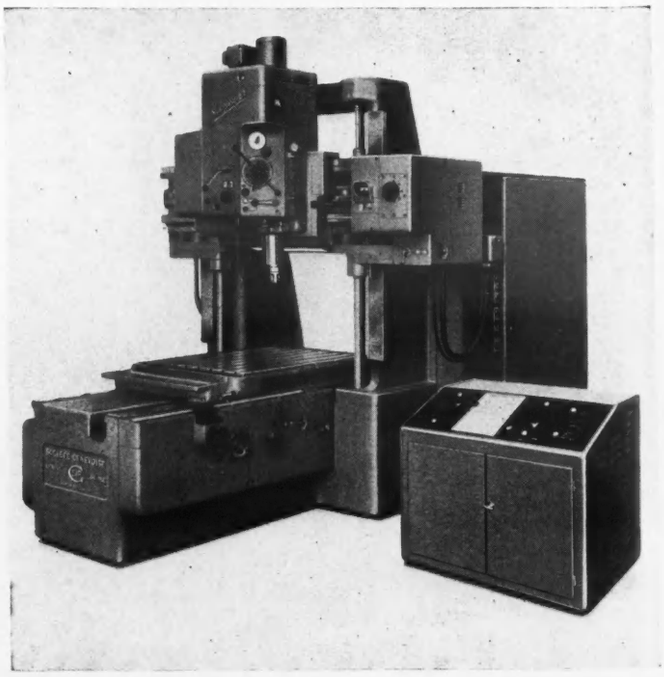




The ABA-Werk machine illustrated on the LEFT is to be shown by the Rockwell Machine Tool Company Ltd., and its 15¾in by 27½in table is set by hand with reference to projection screens to a stated accuracy of 0·0001in.

The "Matrix" jig borer of the Coventry Gauge Tool Company, Ltd., shown on the LEFT BELOW incorporates an optical measuring system developed in conjunction with Hilger and Watts, Ltd. With this system the lateral and transverse movements of the table can be viewed on two large illuminated scales and settings can be made in either direction directly to within 0·0001in. The spindle of the machine is driven from a hydraulic motor and has steplessly variable speeds up to 2000 r.p.m. The table has a working surface of 24in by 36in.

Full details of the "Hydroptic-6A" machine shown on the RIGHT BELOW are given elsewhere in our articles on the exhibition. This machine is equipped with the "DIR" automatic co-ordinate repeating system by which forty different settings can be recorded on two interchangeable drum memories. With this equipment the table and spindle head, it is stated, can be accurately positioned to within 0·00004in, and the guaranteed accuracy for all displacements of the worktable and spindle head saddle of this machine is given as 0·00015in.



tive conventional, special purpose and automatic cycle machines. A new development in this class of machine is one which is suitable for plunge grinding regular and irregular profiles of concave or convex form at high production rates on work up to 8in diameter. On this machine radial movement of the worktable, which is supported on fulcrum rollers, provides the controlled grinding infeed and rapid withdrawal of the workpiece from the grinding wheel. The work cycle is single lever operated after initial setting up and the tailstock automatically moves into position to locate the component in the holding fixture under predetermined hydraulic pressure.

The multi-wheel grinder shown in Fig. 12 is designed to grind in one operation components having a number of diameters, such as crankshaft and camshaft journals. It takes components up to 12in swing and 40in long between centres and the wheelspindle accepts 36in wheels over a span of 32½in. Truing of the grinding wheels is effected by a hydraulically operated dresser mounted on the wheelhead, and each wheel is dressed by a separate diamond controlled from the front of the machine. The wheelhead is equipped with a rapid approach and withdrawal movement which may be varied to suit the type of workpiece ; it is provided with three feed rates for roughing, finishing and, for employment where necessary, an ultra-fine ratchet or intermittent feed. The wheelhead is driven by a 30 h.p. motor and the heavy-duty, dead-centre workhead through vee belts by a 2 h.p. motor.

An automatic high-speed tap grinding machine for taps and threaded components up to ½in diameter over a length of 5in and taking pieces up to 12in between centres is suitable for a right- or left-hand helix up to 5 deg. and a standard pitch range from 6 to 60 t.p.i. The machine has a built-in temperature control for the spindle lubrication system to ensure accurate sizing of the grinding wheel, an automatic pantograph diamond dresser or wheel crusher, and an automatic sizing gauge, which functions at previously established intervals and at the end of every wheel forming cycle.

The work feed mechanism consists of an electrically and pneumatically-operated feed unit and drum magazine into which up to thirty-six tap blanks may be spring loaded. The magazine is designed to ensure that when taps are fed into the machine, correct relationship is established between the flute and wheel for relief grinding. The indexing mechanism of the feeder unit is automatically interlocked with the machine grinding cycle. Automatic machine control provides a cycle of feeding a tap into the work drive, locating, grinding and ejecting it, gauging and dressing ; the cycle repeats until the magazine is empty when the machine stops and both visible and audible signals are given to indicate that reloading is necessary.

An automatic crankpin grinding machine for large-scale production of automobile or diesel engine crankshafts to be exhibited incorporates a fully automatic cycle for grinding in-line crankpins. After preliminary setting-up, all necessary controls are interlocked and the machine functions are governed from a single control station. For establishment of finish diameter, an " OMT-ETAMIC " two-stage air sizing gauge is employed. A signal emanating from this unit when correct size is reached causes retraction of the wheelhead which, on reaching its rear position, actuates a control circuit causing the table to index to the position of the next in-line pin and consequent recommencement of the grinding cycle. When all in-line diameters are ground and the table has returned to the loading position, truing of the grinding wheel by a wheelhead mounted dresser and compensation for wheel wear and dressing automatically takes place. To obviate manual handling of shafts this exhibit will be equipped with a pneumatically-operated work transfer mechanism.

**Coventry Gauge and Tool Company, Ltd.**

The precision measuring and gauging instruments demonstrated upon the stand of the Coventry Gauge and Tool Company, Ltd., Coventry, will include the " N.P.L.-Matrix " measuring machine for internal diameters illustrated in Fig. 13. This machine is designed to measure internal diameters from 0·1in to 3in and measurements can be made down to a depth of 1in to an accuracy of ±0·00001in or to a full bore depth of 3in with a proportional decrease in accuracy.

The machine is basically a comparator using reference standards built up from slip gauges and lapped end pieces. It has an elevating worktable which can be raised,

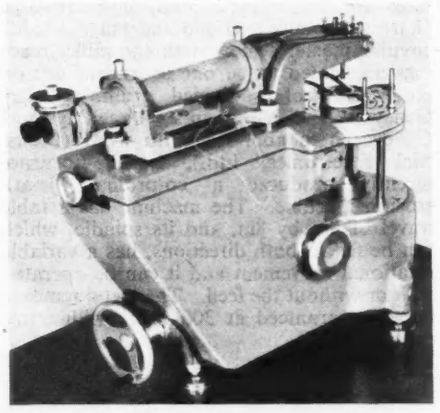


**Fig. 13—Measuring machine for internal diameters from 0·1in to 3in—Coventry Gauge**

lowered and rotated to bring the work into position, an adjustable slide carrying an autocollimator, and a measuring head. The measuring head, pivoting on a horizontal axis, has a double-ended stylus of a length within about 0·05in of the bore diameter. The head is moved so that it contacts in turn each end of the diameter being measured. Two optical mirrors are mounted on the head facing the autocollimator, and they are adjusted so that one reflects the image of the autocollimator crosswires back into the eyepiece when one end of the double-ended stylus is touching the bore, and the other mirror acts similarly with the other end of the stylus. Settings of the autocollimator can be made to give a measurement accuracy within 0·000005in for each position of the stylus.

A Watts microptic autocollimator is fitted to the machine, and one main division on the measuring drum of the instrument corresponds to an angular displacement of one second of arc. The distance between the axis of rotation of the measuring head and the axis of the double-ended stylus point is made equal to 2·062in, so that an angular displacement of one second of arc corresponds to a 0·00001in travel of the stylus. The measuring head unit pivots on two precision ball bearings held in a pair of supporting arms, integral with the slide, and its mirrors can be tilted vertically and horizontally by knurled screws.

The reference standard for the machine is of box form, built up so that the internal dimension of the box is within about ±0·0005in of the size of the bore under

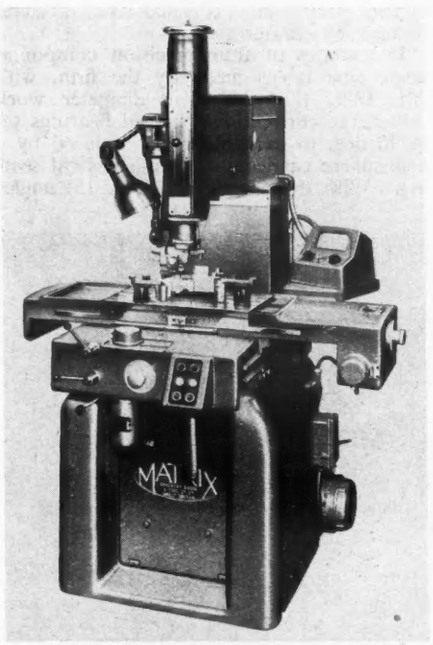



**Fig. 14—Three-dimensional measuring machine for complicated components—Coventry Gauge**

measurement. It comprises two lapped steel end-pieces, separated the appropriate amount by two combinations of slip gauges. The standard is lightly held by a clamp to prevent the wringing films from breaking during use. The size of the standard can be relied on within 0·00001in, provided that slip gauge combinations of equal length are selected and that care is exercised in wringing the individual parts together.

This firm's three dimensional measuring machine, shown in Fig. 14, is designed to simplify the measurement of complicated components and is particularly suited for the measurement of diameters and position of holes relative to datum faces and depth and squareness within its capacity. By employing a " Matrix " dividing head or circular table, cams and components with irregular contours can be measured quickly and reliably.

The machine owes its versatility to its combination of measuring systems. The compound tables can be rapidly positioned by power-driven leadscrews and finally set by hand to 0·0001in whilst the measuring head is carried on a vertical quill embodying an optical scale showing movements of 0·0001in. Movement of its probe in the horizontal plane are measured to 0·00001in, and displacements are observed on an electrically energised meter. The quill is counterbalanced by adjustable weights which can be either set to exact balance or to apply a measuring pressure to the probe of 8 oz or more as required. An accurate spindle with a quick-locking taper bore within the nose of the quill facilitates the fitting of various forms of measuring attachments.

The complete measuring unit is carried on a vertical slide which is power-operated by an independent electric motor and may be rapidly raised or lowered to any desired position with reference to a scale. Setting up for measurements is simple and effortless as the approximate position of the probe in

relation to the work is obtained by power and finalised by hand. The final settings are obtained by control knobs with reference to dials reading to 0·0001in direct by vernier. These dials are mounted just below the surface of each table adjacent to the hand control knobs and protected from dirt and damage by armour glass.

In a series of four precision compound angle sine tables made by the firm, with 9in, 13in, 18in and 26in diameter work tables, the conventional hinged bearings set at 90 deg. to each other are replaced by a hemisphere carried in a hemispherical seating. With this instrument (Fig. 15) angles

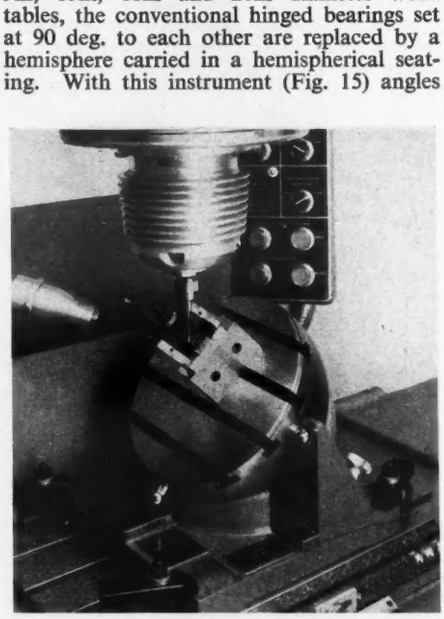


**Fig. 15—Compound angle sine table mounted on hemispherical seating—Coventry Gauge**

up to 45 deg.—both single and compound—can be set quickly and simply. It is claimed that the table is accurate to ±10 seconds of arc, and its angle is set by inserting slip gauges between ball-ended pegs and platens on the base. One of the balls rests against the face of a detachable vertical straight-edge to ensure that the axis of the hemisphere, which passes through this ball, remains parallel with the datum abutment faces. The other ball is spaced 90 deg. apart from the first and governs the inclination of the surface of the worktable about the axis determined by the first ball. When setting is completed, the table is locked by tightening a nut to secure the central bolt ; due to the ample area of contact between the hemisphere and its seating, no great pressure is required for this purpose.

One of the latest " Matrix " products to be shown is a range of magnetic clutches which can be supplied as either single or duplex units for applications such as starting and driving ; brakes ; combined brake and clutch ; or for reversing clutches. These clutches are made in eight sizes from 2½in to 8in with static torques ranging from 15ft/lb to 900ft/lb respectively.

### Société Genevoise

The recently introduced " Hydroptic-6A " optical jig boring and milling machine of Société Genevoise, Ltd., Newport Pagnell, Bucks, is illustrated on page 1050. This machine has a spindle head driven by an 8 h.p. motor and its measuring system with co-ordinate settings on projection screens enables readings to be made to within 0·0001in. The guaranteed accuracy for all displacements of the unit-table and spindle head saddle is 0·00015in. The " DIR " automatic electronic co-ordinate repeating device available with the machine enables forty different co-ordinate settings to be recorded on two interchangeable magnetic drum memories, which are easily detachable and can be stored for repeated series production.

In operating the jig borer, the accurate positioning of the table and spindle head to within 0·00004in is controlled by photo-electric microscopes which view lines engraved on steel standard scales built into the worktable and the spindle head saddle. These standard scales are used in all cases as the sole measuring element, whether the machine is used manually or under automatic control.

The operator is able constantly to check the actual positioning accuracy by observing the projection screens, and manual settings can be interposed without interfering in any way with the automatic repetition of the recorded positions. The hydraulically-operated table of the machine gives a stepless range of milling speeds up to 20in per minute, and a rapid traverse of 100in per minute. Four transverse milling speeds of the spindle head saddle from 1⅛in to 7¼in per minute, are available.

This firm will also exhibit a 31½in diameter optical circular dividing table in which settings are made by a built-in microscope viewing a totally enclosed and finely divided circular master scale. With the table, readings are stated to be one second of arc on the vernier of a divided drum. Société Genevoise d'Instruments de Physique, Geneva, in collaboration with AGIE (Industrial Electronics, Ltd.), Losone-Locarno, recently produced a co-ordinate spark erosion machine. The machine has a table travel of 8in by 8in, and its spindle, which can be fed in both directions, has a variable rotational movement and it can be operated with or without the feed. The metal removal rate is guaranteed at 300 cubic millimetres per minute.

### H. W. Kearns and Co., Ltd.

Early last year H. W. Kearns and Co., Ltd., Broadheath, near Manchester, introduced the No. 3 universal boring and milling machine equipped with electronic controls and since then six of these machines, described in detail in our issue of March 27, 1959, have been successfully operating in service. These machines, one of which is being exhibited, have a 4in diameter spindle combined with a facing chuck capable of machining up to 42in diameter. A 4ft by 9ft main table is fully supported on a saddle on an 8ft 9in wide main bed. The A.E.I. automatic co-ordinate setting system fitted on the machine comprises servo mechanisms operating over the 7ft vertical traverse of the spindle slide and 8ft transverse movement of the main table. Movements can be made to any position according to the co-ordinates, which are indicated on dials on the control desk. Six dials with clearly displayed figures are provided for each of the two ordinates and can be set to any required displacement in tens of inches, inches and four decimal places from any predetermined datum. The dials can be set individually by hand or in groups by standard punched cards, a pack of which can be carried in an automatic card reading unit. These cards can be arranged in sequence and when placed in the feed hopper are individually read before being ejected into the collecting hopper.

The five other machines on this firm's stand will include the new " 451 P " " Optimetric " horizontal surfacing, boring, milling, drilling and tapping machine (Fig. 16) which is intended for both tool room and general workshop use. It has a main bed of cellular design with a channel in the centre directly under the centre line of the travelling spindle. This channel houses the longitudinal screw and shaft, together with their associated mechanisms, and is filled with lubricant, so that these parts, including the centre bedway, are submerged in an oil bath which ensures ease of operation, a minimum of load on the feed mechanism, freedom from slip-stick, long life and accuracy. The centre guide on the saddle slides in this bed channel and the outer ends of the saddle are carried on large rollers which rotate on anti-friction bearings and are supported by the outer bedways.

A 7½ h.p. totally-enclosed motor is bolted at the back of the main bed where any heat or vibration generated has a minimum effect on the machine. Drive from this motor is transmitted through plastic belting to a

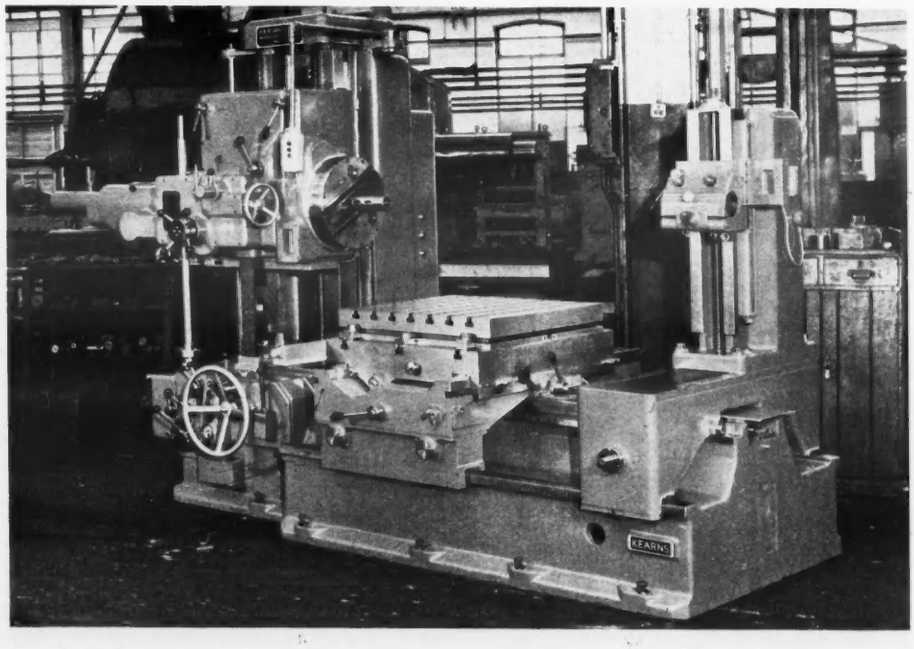



**Fig. 16—Horizontal surfacing, boring and milling machine with hydraulic tool clamping and release to the spindle—Kearns**

nine-speed gearbox from which a similar belt transmits the power to the spindle slide. Three gear changes in the spindle slide, combined with the nine speeds of the main drive box, give a total of twenty-seven speeds. The 3in travelling spindle is combined with a built-in automatic facing chuck for up to 24in diameter. The feed mechanism to the facing slide consists of only three simple components : a large diameter concentrically-mounted worm which drives twin spiral gears working directly into two racks attached to the slide.

A new and important feature on the machine is a hydraulic tool release and clamping system to the main spindle. In order to ensure accurate and constant effort when holding the No. 40 non-stick mandrels into the spindle nose, the central draw bar is pulled into position by a powerful spring housed in the end of the main spindle, a bayonet catch enabling the mandrel to be withdrawn easily and quickly. The spring is overcome by applying a hydraulic pressure to a cylinder attached to the end of the spindle.

The " Optimetric " system provided to the vertical adjustment of the spindle slide and boring stay bearing and transverse movement of the table enables setting to be made to 0·001in to a limit of error of ±0·00025in.

### S. Russell and Sons, Ltd.

A recently developed automatic cold sawing machine for ¼in to 3in diameter bar stock, made by S. Russell and Sons, Ltd., Leicester, is illustrated in Fig. 17. The machine is of rocker head design with its head mounted on trunnion bearings on a fabricated steel cabinet base. The saw spindle and worm gear drive are housed at the front of the head and the drive is transmitted from a 5 h.p. motor at the rear of the head through two-step pulleys and vee-belts. A 12½in diameter segmental circular saw is fed into the work by the rocking of the head by an air cylinder. The feed speed is controlled by an oil dashpot cylinder and needle valve, and an air-operated by-pass valve controls the quick return movement of the head at the end of a cutting cycle.

During cutting the work is gripped on both sides of the blade by independent air-operated vices, each of which imparts a clamping load of about 1200 lb. A bar mounted on the machine bed carries the main work stop incorporating a micrometer head adjustable in 1in increments along the bar. An arm projecting from this head carries a micro switch assembly which is activated by contact with the bar as it is fed through the vices, and this switch sets in motion the automatic sawing cycle. A second work stop on one side of the vice has a fixed length and operates only once for trimming the end of the new bar, afterwards withdrawing automatically until the next bar comes forward. This second stop controls the cutting cycle by means of a micro-switch unit in the same way as the main stop.

Bars are carried in a gravity rack at the side of the machine. The bar being cut is fed into the machine by a pusher trolley driven by cable from a three-cylinder geared air motor and the outgoing work is carried away by a small inclined roller conveyor. Coolant is supplied by a pump in the sump and an ample chip space is easily accessible from the front of the machine.

This firm has also introduced a horizontal cold circular sawing machine for cutting rolled steel joist up to 36in by 14½in using a 48in diameter blade, or 36in by 12in joist with a 42in diameter blade. The saw saddle complete with its own driving motor is fed hydraulically and slides in wide surfaces. Work is clamped on the table by sets of hydraulic plungers mounted on cross heads on the table and situated each side of the saw blade. A side worktable is adjustable at right angles to the saw blade and, if required, a power-operated circular base can be fitted.

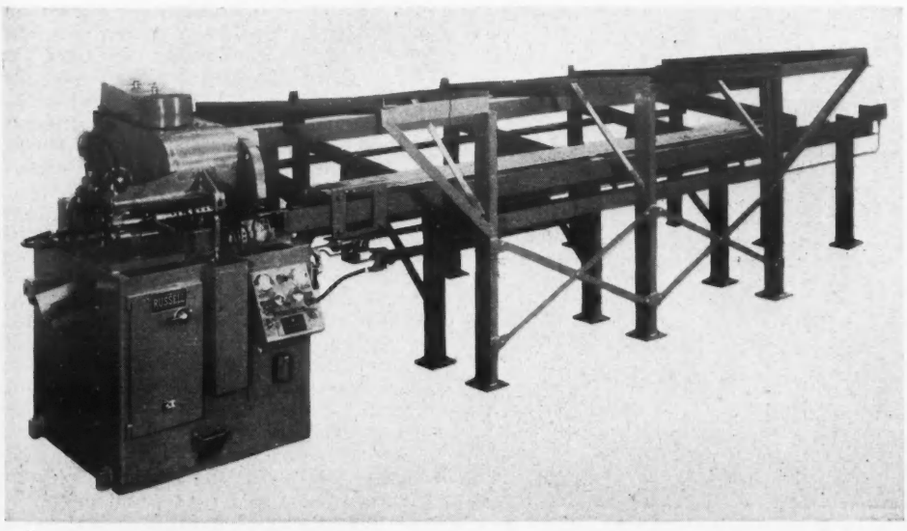


Fig. 17—Automatic cold sawing machine for ¼in to 3in diameter bar—Russell

### Cyril Adams and Co. Ltd.

In our issue of August 22, 1958, we described in some detail the copy band-grinding machine conceived by Armstrong-Siddeley, Ltd., and developed and marketed by Cyril Adams and Co., Ltd., 155, East Barnet Road, New Barnet, Herts. This machine was originally developed for the economic production of the aerofoil section on gas turbine compressor blades, but can well be adapted for similar classes of work. It has at present a capacity for work 14in long by 5in chord width, but a detailed design study for a 48in by 12in machine has recently been completed.

On these machines (Fig. 18) the cutting medium is an interchangeable, endless abrasive band, motor-driven via idlers, around the cutting guide wheel, or work roller, which is of spherical section at the cutting point and has a bonded " Neoprene " tyre around its periphery. In the simple one-to-one gravity copying process used on the machine, the vertical path of the cutting band is controlled by a rigidly connected follower sphere—of identical size to the

Fig. 18—Copy band-grinding machine—Adams

work roller—accurately pitched to the rear of the roller and lightly gravity loaded on to a suitable template. This template is mounted, together with the workpiece, on a movable table underneath, and at an identical pitch to, the work roller and follower. The cutting motion is provided by traversing the table in a direction along the longitudinal axis of the component and at the same time employing an incremental cross-feed to the head which carries the work roller and follower. This feed is incremented in the centre of each longitudinal stroke. It will thus be seen that each portion of the workpiece is automatically traversed twice by the band, the second cut being a " sparking out " or finishing cut. Experiments have shown that, by using a linen twill band loaded with lapping paste in place of the normal grit bonded band, it is possible to achieve superfinished surfaces in the order of 2 to 2½ micro inches, coupled with stock removal of 0·001in per pass. With the normal type of band, cutting Nimonic or stainless steel, finishes of 8 to 10 micro inches are to be expected with cuts of 0·015in per pass.

The longitudinal motion for the table carrying the template and workpiece is obtained from a hydraulic cylinder, and two controls can be set to vary the table speed—in either direction—by infinitely variable amounts throughout the extent of its designed range. The reversal of the longitudinal motion cylinder is effected by trips and switches adjustable along the machine table actuating a solenoid-operated valve. An attachment can be provided to modify the action of these trips and switches in such a manner that the length of the longitudinal stroke may be increased or decreased automatically at each impulse of the incremental cross-feed. This enables the machine to grind close up between angularly displaced shoulders workpieces such as are encountered on many forms of gas turbine blades.

An auxiliary rotating attachment which

can be provided, enables both workpiece and template to be rotated through a predetermined angle under the band wheel and follower, and allows the tracing of steep or highly twisted forms up which the normal machine units cannot climb.

### Sir James Farmer Norton and Co., Ltd.

A development of the conventional two-roll, adjustable angle, bar straightening machine made by Sir James Farmer Norton and Co., Ltd., Salford, Manchester, is illustrated in Fig. 19. In this machine the rolls are mounted one above the other, instead of side by side, and the horizontally-mounted guide blades are readily accessible for changing and adjustment. The machine's capacity is for bars from ½in to 3in diameter and two bars can be processed simultaneously if required. A differential mechanism incorporated in the main drive synchronises roll speed irrespective of roll diameter so that "matched" rolls are not essential.

Adjustment of the machine to bar size is effected hydraulically and the roll pressure can be set at a predetermined figure so that no material damage is done if an operator inadvertently feeds in an oversize bar. The means of full angular adjustment provided for both rolls covers the full range of bar diameters and specially developed roll profiles suit all materials up to 100 tons tensile strength. The hardened and ground alloy steel rolls are solid with their driving shafts and carried on taper roller bearings.

A selection of drives available for these machines, which can be run at speeds from 50ft to 150ft per minute, includes one with a constant throughput speed; or a change speed gearbox can be fitted giving two, three or four speed changes. A variable speed motor drive can be used to give steplessly variable speeds over a selected range when necessary.

A silent running rotary swaging machine for tubes up to 2in diameter and bars up to 1in diameter made by this firm has a slowly rotating spindle by which it combines the advantages of conventional, stationary and rotating spindle machines. Its high-tensile steel spindle, which is suitably hardened and ground on its working faces, is driven at 20 r.p.m. by a 2 h.p. motor through a toothed belt and gearing. The main driving head rotating round the spindle is driven at 200 r.p.m. by a 10 h.p. motor. It houses hardened steel striking rollers carried in an aluminium bronze roller cage; these rollers make contact with the inside bore of an alloy ring shrunk into the main flywheel pulley and the outer diameter of the spindle head.

Other machines on this firm's stand will include a high-speed tube saw and a cropping and pointing machine.

### Wadkin, Ltd.

A recent addition to the machines made by Wadkin, Ltd., Leicester, is a plano miller for work up to 8ft by 5ft by 40in high, which can be fitted with one or two milling heads. Together with this machine there will be one of the firm's electronic positional drilling machines designed for automatic operation from either punched tape or dial settings. Our illustration Fig. 20, shows an articulated arm router having the articulated primary arm arranged to rotate through 360 deg. This machine has a 5 h.p. router head with a 12,000 r.p.m. spindle as a standard, but is available with a 10½ h.p. to 12 h.p. head and frequency changer giving spindle speeds from 6000 to 18,000 r.p.m.

The depth setting of the router head on the machine is power operated from trigger controls on the handles and is arranged to operate in conjunction with four pre-set depth stops. The power rise and fall mechanism is such that the head may be brought down at high speed on to a predetermined stop with an automatic slow approach, just short of the selected stop, to give precision depth settings. The head may be brought down using the trigger controls and arrested at any position between stops, with automatic locking. The head retracts to the top position automatically at high speed on operation of a trigger control on the handles. The machine is designed to cover an area of 2ft square on the main worktable, or alternatively to be used in conjunction with a fixed table at 90 deg. to the standard table, when it will cover an area of 2ft by 3ft. Another articulated arm radial router made by the firm has built-in hydraulic depth control to obviate hand operation of the vertical head slide and to obtain spot-on repetition on depthing work. Instead of the normal front and back manually-operated slides, the head is on a single hydraulically-operated slide giving a total vertical movement of 16in. A precision six-station capstan stop bar incorporated in the slide forms a positive knock-off or stop to the downward feed of the slide. The hydraulic operation of the slide is controlled by a lever at the operator's left hand, through a Wadkin "Hydrotrace" control located on the left-hand side of the slide. This arrangement gives infinitely variable control to the rise and fall movement of the head, with reference to a graduated dial fitted underneath the "Hydrotrace" valve. A handwheel at the top of the six-station stop bar gives adjustment to an independent manually-operated stop which can be brought into use where necessary. This mechanism can be used to give depth control on machining deep pockets by progressive steps and once the hydraulic stop setting has been overrun it takes over, ensuring foolproof setting.

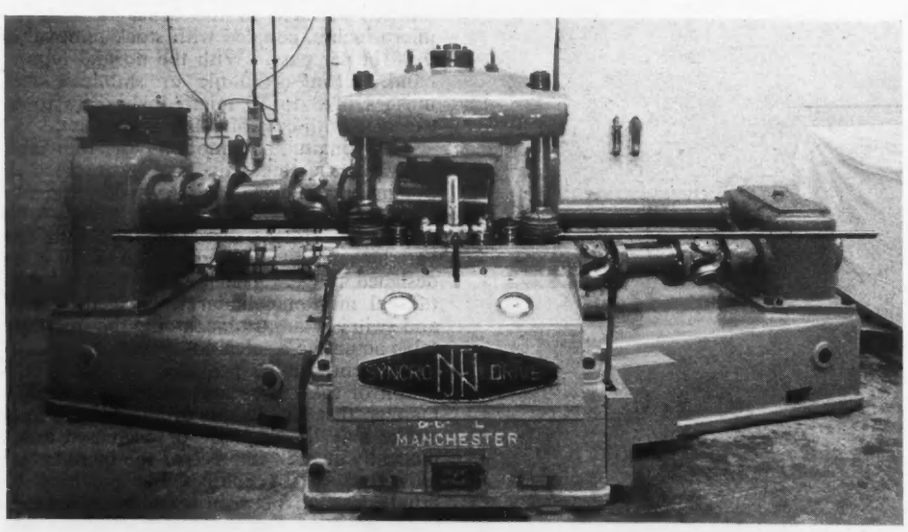



Fig. 19—Two-roll, adjustable-angle straightening machine for tubes and bars from ½in to 3in diameter—Sir James Farmer Norton and Co.

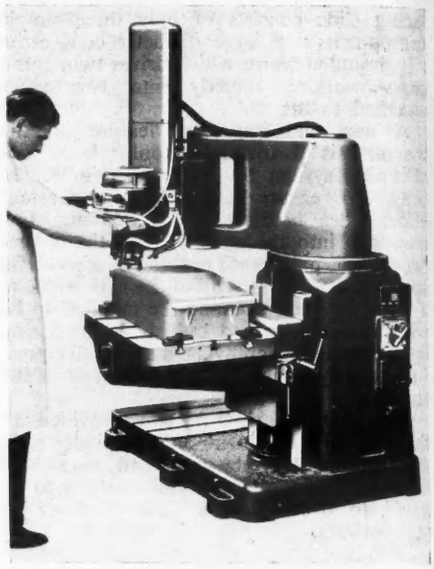


Fig. 20—Articulated arm router with trigger-operated depth setting of the head—Wadkin

### Optical Measuring Tools, Ltd.

The optical measuring equipment made by Optical Measuring Tools, Ltd., Maidenhead, now includes a 30in automatic indexing table which is produced in conjunction with E.M.I. Electronics, Ltd., and is controlled by manual setting or punched tape. For this table the basic measuring element of the automatic positioning system is a 12in rotary "Inductosyn" which indicates the actual platen displacement and not the movement of the worm drive or lead screw. Any mechanical wear which might occur has no effect, therefore, on the setting accuracy of the system, which is within ±3 seconds of arc with repeatability to ±1 second.

In conjunction with the National Engineering Laboratory this company has developed the new roundness measuring machine we illustrate in Fig. 21. This equipment is stated to have a very high order of precision and its cost is expected to make it suitable for general workshop applications as well as employment in a standards room. It has a measuring range from ½in to 6in for internal diameters and $\frac{1}{16}$in to 6in for external diameters.

The instrument comprises a bearing in which a spindle carrying a gauging pick-up is power rotated at 1 r.p.m., and the pneumatic design pick-up bears a spring-loaded controlling stylus to contact the work periphery. As the spindle is rotated the stylus

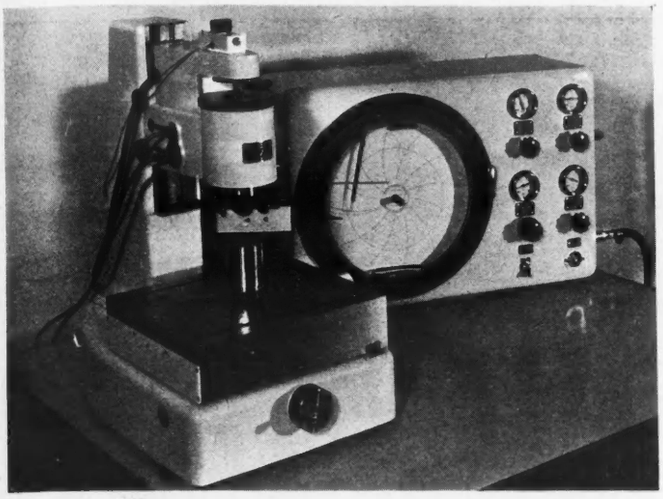


Fig. 21—Roundness measuring machine for work up to 6in diameter. The state of roundness of a component is recorded on a chart on which a radial space of 0·05in represents 0·00001in—Optical Measuring

moves round the periphery of the component and produces a signal in the pick-up head. This signal is amplified and fed to a circular chart recorder indicating the state of roundness in documentary form (on the recorder chart a radial space of 0·05in represents 0·00001in at 5000 magnification).

To obtain a high degree of concentricity and low frictional torque necessary in this equipment there is used an air bearing which requires a working pressure of 60 lb per square inch. The concentricity with this bearing is maintained to within 0·000005in. The magnification obtained is 5000 or 1000, the change-over being effected by rotating a small knob at the top of the bearing unit.

To indicate the very comprehensive range of pneumatic gauging equipment it now manufactures, the firm will show a selection of comparator units with gauging accuracies of 0·00005in to 0·00000625in, together with special purpose models for checking jet bores and tapered components. Illustrative of the latest developments in the field of quality control by pneumatic gauging, a fully automated assembly for loading, gauging, accepting, grading and rejecting components will be in operation.

Applications of the " OMT-Etamic " head for size determination and automatic control of machine cycle will be seen on a Newall-Keighley cylindrical grinder in operation on the stand.

### Brooke Tool Manufacturing Company, Ltd.

Typical applications of unit heads in building up special purpose machines have been arranged by the Brooke Tool Manufacturing Company, Ltd., Greet, Birmingham, together with a selection of screw feed and cam-operated heads. The two cam-operated units to be shown have ¾ h.p. and 1½ h.p. motors, and have maximum drilling capacities of ½in and ¼in diameter ; whilst the screw feed heads are available with motors from 3 h.p. to 15 h.p. and are suitable for drilling 1¼in to 3in diameter holes in mild steel.

Two of the three unit head machines to be shown are of special purpose design for the production of a differential bearing cap and a motor-car rear axle. The centre column rotary transfer machine for differential bearing caps is illustrated in Fig. 22, and is built up from standard elements. Machines of this design can be supplied with from two to eight working stations and with both horizontal and vertical unit heads. The motor-car rear axle drilling machine of three way construction is employed for drilling six holes in each of the end flanges, and ten holes in the differential housing face.

This firm is also to exhibit a complete range of cutting tools including high-speed steel milling cutters ; inserted blade facing heads ; end mills, gear cutters, hobs, form tools, and metal slitting saws.

### J. Parkinson and Son (Shipley), Ltd.

From the group of milling machines being shown by J. Parkinson and Son (Shipley), Ltd., Shipley, Yorks, we have selected for illustration in Fig. 23 the vertical machine with a swivel head. The spindle of this machine is driven through gearing by a 7½ h.p. motor, there being twenty-four speeds available in any of three selected ranges from 18 to 1000 r.p.m.; 24 to 1300 r.p.m.; or 27 to 1500 r.p.m. These speeds are shown by a direct reading dial and the setting of a selector lever determines a high- or a low-speed series, in each of which twelve speeds are provided. The spindle

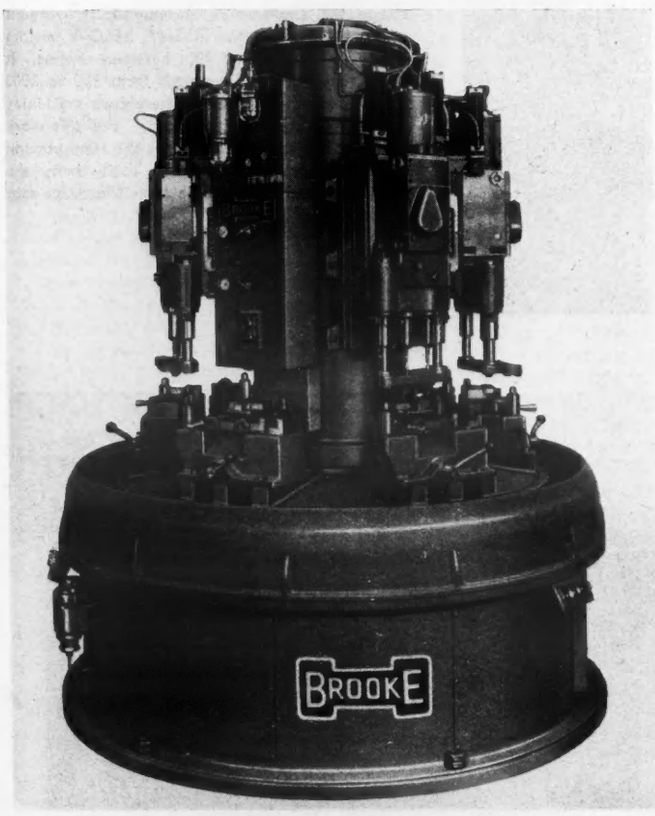



Fig. 22—Centre column rotary transfer drilling machine built up of standard units—Brooke Tool

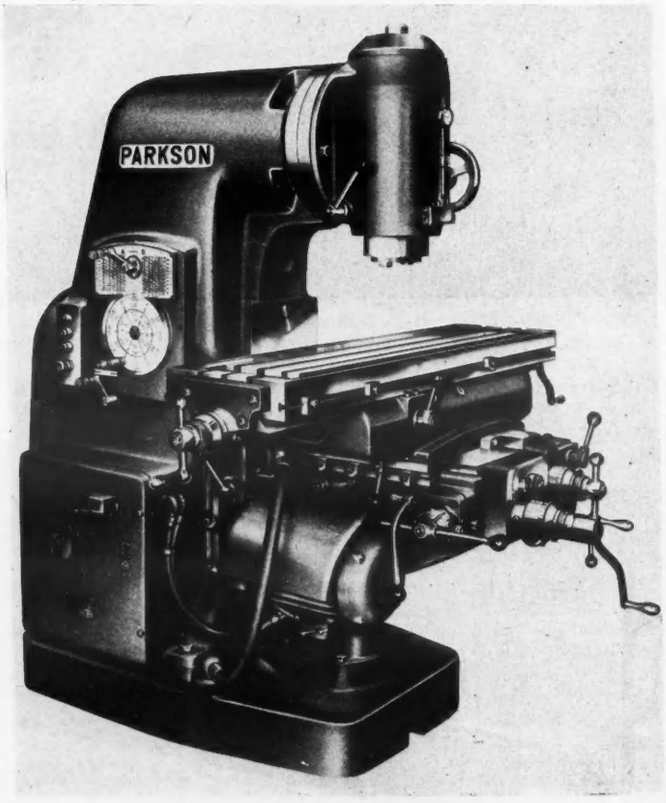
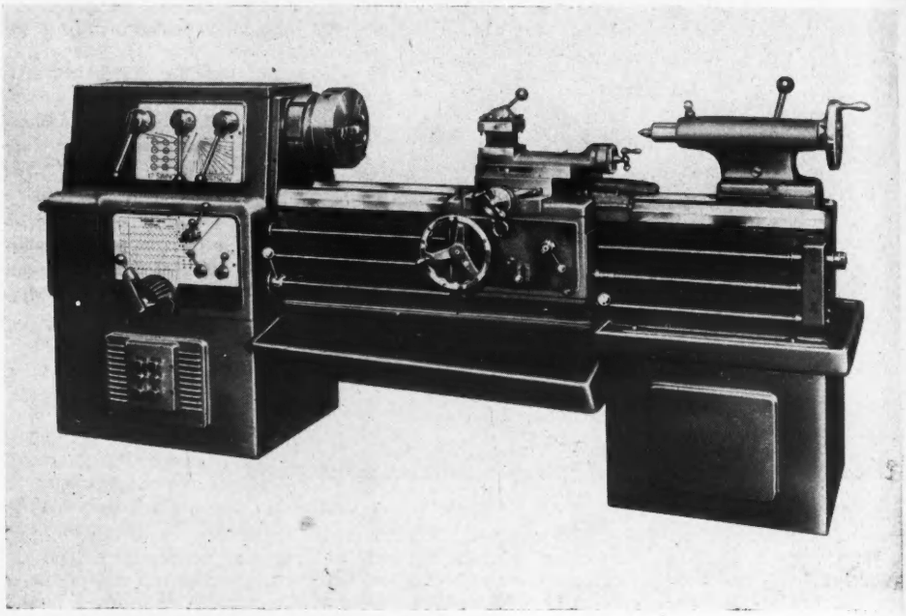
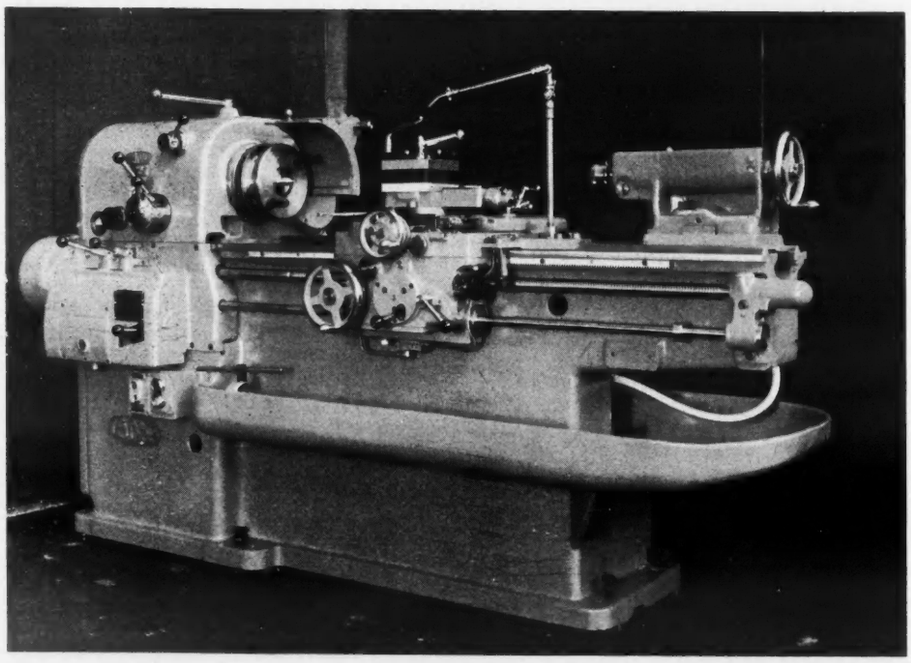



Fig. 23—Vertical milling machine with swivel head—Parkinson

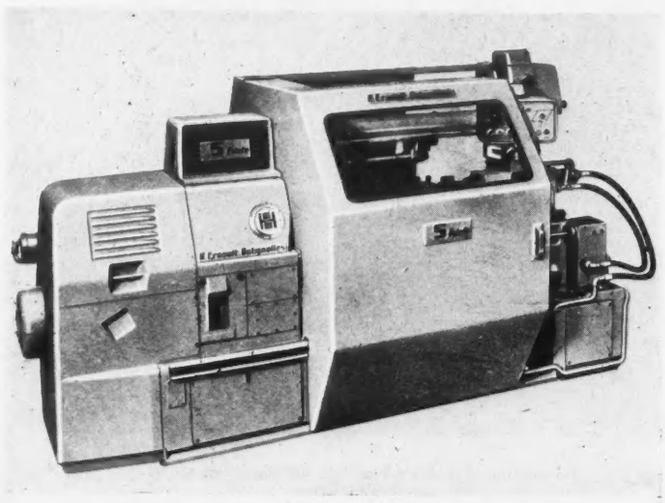
# Lathes

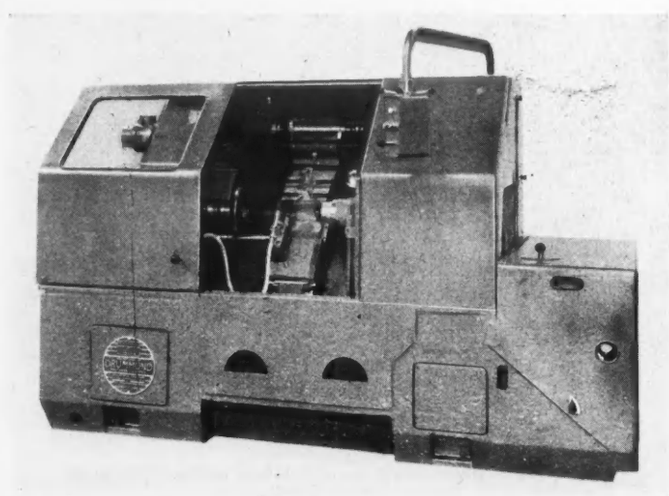
As with most other basic machine tools both the performance and the appearance of the lathe, that most versatile of machines, have been considerably improved over recent years, and our illustrations show four of the contrasting designs which will be seen at Olympia. The machine on the RIGHT is a new 17in swing lathe, developed by T. S. Harrison and Sons, Ltd., and available in bed lengths up to 79in. It has an all-geared headstock driven by a 10 h.p. motor and giving twelve spindle speeds from 32 to 1500 r.p.m. A reversing clutch is fitted and the gearbox allows the cutting of up to 120 threads per inch. A sliding, surfacing and screwcutting Lang lathe of simple, straightforward design and clean appearance shown BELOW swings up to 13in over the bed and 7½in over the saddle and admits bar up to 1½in through the spindle. It has twelve spindle speeds from 25 to 1105 r.p.m. and twenty-eight longitudinal feeds from 0·042in to 0·003in per revolution with surfacing feeds from 0·021in to 0·0015in per revolution.





The two machines illustrated BELOW will be on the stand of Drummond-Asquith, Ltd. That on the LEFT is made by H. Ernault-Batignolles and swings 17⅞in over the bed. It is made in two models taking 20in or 39½in between centres. It has a spindle speed range from 100 to 3150 r.p.m. and is designed for completely automatic multi-cycling copying work. A new setting technique incorporated in the lathe uses inexpensive round masters and easily produced cycle control cards. The standard design of Drummond "Maxipilot" hydraulic copying lathe on the RIGHT BELOW swings 16in over the bed and 20in between centres. It has a range of spindle speeds from 300 to 3000 r.p.m., and at Olympia will be shown machining a final drive flange for a tractor. For this work the front copying slide machines the stem portion of the component, the rear tools make the under-cuts, and a third slide faces the inside face of the flange.





head can be swivelled up to 50 deg. to the right or left, and in it the spindle rotates in precision taper bearings in a large diameter splined quill. Under handwheel control with reference to a graduated dial the spindle has a vertical movement of 4in in the head.

The 51in by 13in table of the machine has twelve longitudinal and transverse power feed rates from ½in to 10½in per minute with a rapid traverse speed of 100in per minute. Its vertical power feed rates are from ¼in to 5½in per minute. A separate 2 h.p. motor used for feed drives enables the power table movements when the driving spindle motor is not running.

Together with this company's gear planing machines and gear testing equipment there will be seen the " Gearbur " machine (Fig. 24) for removing sharp edges and burrs

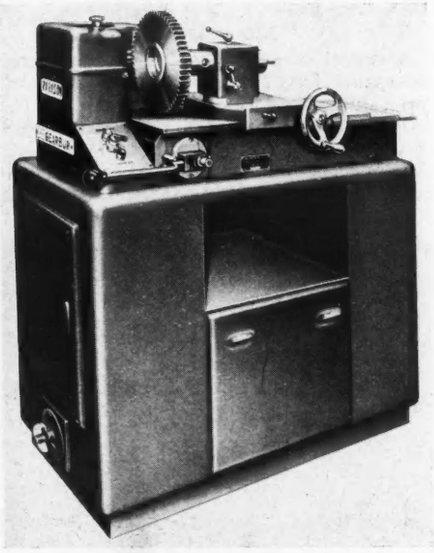


Fig. 24—De-burring machine for gear teeth—Parkinson

from the teeth of gears up to 11in diameter by 11in face width with teeth from 25 D.P. to 5 D.P.

The gear is mounted on a freely rotating spindle and brought into mesh with a grinding wheel on which there is formed a profile with a helix to suit the pitch tooth form of the gear. When the grinding wheel is started up it acts as a hob or worm and rotates the gear, which is advanced sensitively towards the grinding wheel until all the teeth are slightly chamfered or deburred.

One grinding wheel is required for each pitch and pressure angle for spur gears and the machine deburrs gears at any number of teeth within the above capacity. The grinding wheels used can be profiled, and redressed in a suitable lathe using a carbide-tipped form tool. Helical gears up to 30 deg. helix can also be deburred by the machine, using a grinding wheel profiled to suit the transverse pitch and gear tooth form.

### Landis Lund, Ltd.

The machines in operation on the stand of Landis Lund, Ltd., Cross Hills, Keighley, will include an automatic crankpin grinder which swings 16in by 32in long work and is hydraulically operated, including the clamping fixture. Under its automatic cycle the feed is arranged for a quick approach of the grinding wheel until it is in the cheek grinding position. A reduced rate of feed is then engaged for grinding the cheeks and further reduced rates of feed when grinding the crankpin diameters, final sizing being effected by the firm's " Microfeed " system operating in conjunction with automatic sizing by means of a pneumatic-electric contact gauge. The grinding wheel has a diameter of 36in and its dressing is carried out by an attachment mounted on the grinding headstock of the machine. In addition to dressing the periphery of the wheel it also dresses the full radii on each corner.

An automatic camshaft form grinding machine swings work up to 5½in diameter by 26in long and has a fully automatic cycle. The work drive is transmitted through vee belt and the speed of work rotation is automatically slowed down for finishing with automatic position stopping of the head for convenient loading. A Gardner double-spindle disc grinding machine is shown with a through-feed fixture and fitted with automatic gauging and size control. It is capable of grinding two parallel surfaces on components up to 4in wide.

### John Lang and Sons, Ltd.

The model " B," 20in by 68in sliding, surfacing and screwcutting lathe incorporating preselection means for speeds, feeds and threads, made by John Lang and Sons, Ltd., Johnstone, Renfrewshire, is now available with hydraulic profiling equipment and a new automatic screwcutting system. The hydraulically-operated screwcutting equipment can be brought into use immediately after a component has been profile turned to thread any required portion of the workpiece. For this operation the threading tool is mounted in the square turret of the machine and, by setting the swivel slide at a suitable angle, threads can be produced by side cutting, to enable fewer cuts and a good finish.

With this equipment the threading tool feed for each successive cut is at a diminishing rate until the total depth of thread is reached. The speed of operation is limited only by the maximum speed at which the leadscrew nut can safely be engaged—65in per minute. This gives typical maximum work speeds of 1300 r.p.m. for twenty threads per inch ; 650 r.p.m. for ten threads per inch ; and 260 r.p.m. for four threads per inch. Tungsten carbide tools can be used when cutting ten threads per inch and finer on suitable diameters with this range of speeds. All threads per inch, except those ending in eighths, can be cut to a maximum depth of 0·135in with the equipment.

The automatic screwcutting cycle is started after the setting of thread length stops ; the required depth of thread set on a dial ; the required pitch set on a second dial, and the spindle speed selected on the fasthead direct-reading dial. In the cutting cycle, when the first pass has been completed, a length stop actuates a control valve which stops longitudinal movement of the saddle, withdraws the tool slide, advances the threading tool ready for the next pass, and engages the quick power traverse drive to return the saddle to the starting position, at a speed of 26ft per minute. When the starting position has been reached, a length stop again actuates the control valve which disengages the quick power traverse drive, moves the threading tool slide forward, and engages the leadscrew nut at the correct position, to restart the cycle.

An indexing power chuck has been developed by this firm for the production of parts in which two, three or four branches have to be machined at right angles, such as on pipe fittings. These chucks are opened and closed by power, as in the conventional air chuck, and the workpiece is indexed progressively in 90 deg. steps, indexing and relocking being effected without need for stopping the machine by operation of a hand or pedal control valve. It is stated that the indexing operation takes place in less than one second and accuracy is within 0·015in at a 12in radius. The chuck can be run at speeds up to 1500 r.p.m., and its actuating air cylinder on the back of the machine spindle uses airline pressure at 85 lb per square inch. These units, one of which is shown in Fig. 25, are made in two

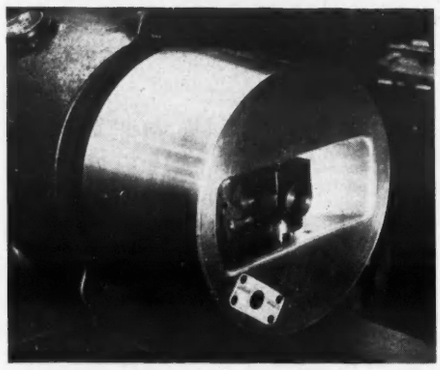


Fig. 25—Indexing power chuck for multi-branch parts such as pipe fittings—Lang

sizes of 11in and 14in diameter and with respective jaw gaps of 3¼in and 5in open and 2½in and 4½in closed.

In addition to improved models of other lathes in its range the firm will also show a new centring machine for ½in to 6in diameter bars. The driving head of this machine has two spindles, one of which is used with a facing cutter to prepare the rough ends of bars, forgings, &c., prior to centring by a combination drill on the second spindle.

### Wild-Barfield Electric Furnaces Ltd.

Equipment to be exhibited by Wild-Barfield Electric Furnaces Ltd., Watford, Herts., will be representative of the firm's resistance furnace, induction heating and vacuum equipment. The furnace exhibit will show the scientific control of an active process atmosphere, and to demonstrate this, two types of sealed quench furnace will be exhibited operating in conjunction with an endothermic gas generator. Complete control of atmosphere conditions to suit changes in material and/or application is achieved in the larger furnace by full automatic dewpoint control on both the gas generator and the furnace. A smaller furnace of hand-operated slipper design shown is for the clean hardening of small components such as parts of small ball bearings. The G.W.B. endothermic generator will be operating on bottled liquid petroleum gas-propane.

An interesting demonstration will be the manufacture of low pressure die-castings arranged by Alumasc Limited of Burton Latimer, Northants. The process will be demonstrated using a Wild-Barfield mains frequency induction heated aluminium holding furnace of 300lb capacity, replenished from a mains frequency induction heated bale out furnace of similar capacity. The high frequency induction heating equipment will include a new 2·5kW generator, with intermittent rating up to 3kW, incoporating full range power control. In addition, a standard 25kW set will be exhibited in conjunction with a new progressive vertical and rotary hardening machine, designed for a wide range of application.

# Models at the I.C.E. Conversazione

*Each year, a notable part of the annual conversazione held at the Institution of Civil Engineers, in Westminster, is the display of engineering models and of apparatus used in various engineering research problems. The conversazione this year was held on Wednesday, June 15, and, as customarily, about thirty exhibits were to be seen in the library. A selection from these exhibits is briefly described hereunder.*

THE British civil engineer, and the profession and industry which he sustains, are passing through a period of quite vigorious activity and of steady progress. This state of affairs was well reflected by the display of models to be seen at the Institution of Civil Engineers' conversazione held last week. The display included a number of examples of noteworthy projects, including those still on the drawing-board, and those actually completed, shown by models, drawings and dioramas. They included dams such as those at Kariba, in Rhodesia, and at Clatworthy, near Taunton ; the new Notting Hill Gate Station on the London underground, and proposals for the new Victoria tube at Oxford Circus ; the reconstruction of Barclay Curle and Co., Ltd.'s, Clydeholm shipyard at Glasgow ; various models of bridges, including the Tamar suspension bridge now under construction, and the Narrins bridge at Perth, Western Australia ; and a number of urban reconstruction schemes, including multi-storey buildings. Research studies were also prominent ; they included subjects such as the action of groups of piles in a uniform stratum of clay, the behaviour of bored piles, and the use of models in structural design.

### Density Currents and Silting in Docks

Navigation locks in estuaries often separate bodies of water of different salt content and hence different density, and this inequality can produce currents of sufficient strength to transport fine bed material into and through the locks. When the lock gates are open the denser estuary water flows in near the bed while a compensating outflow of less saline water takes place in the upper layers. The Hydraulics Research Station, D.S.I.R. (director, F. H. Allen), exhibited a model study of this problem.

The Queen Elizabeth II dock of the Manchester Ship Canal Company (THE ENGINEER, January 22, 1954, and December 19 and 26, 1952) is connected to the Mersey Estuary by a navigation lock fitted with sliding caisson gates. The dock level is maintained by admitting relatively silt-free water from the nearby Manchester Ship Canal and, as the canal is partly supplied by upland rivers, the water in the dock is less saline than that in the estuary outside the lock at high water, the salinity difference varying from five to nine parts per thousand.

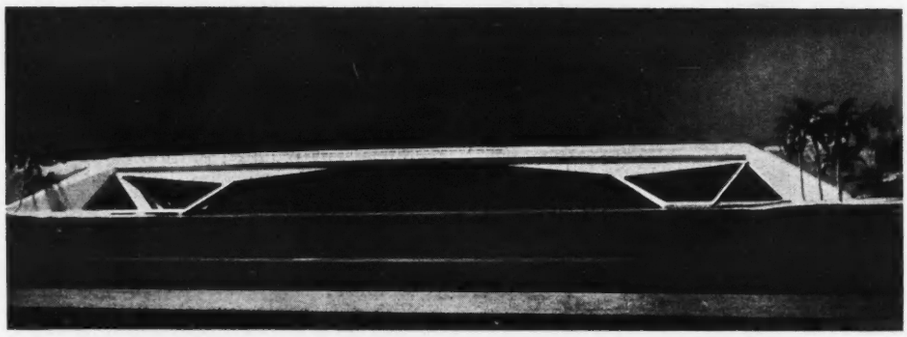
Frequent dredging is required in the dock since silting occurs at the rate of 3000 to 8000 cubic yards per week, and a field investigation carried out by the Hydraulics Research Station has shown that most of this material is brought into the dock from the estuary by strong currents resulting from the difference in density. In one survey the bottom 10ft of lock water flowed into the dock at about 1ft per second for twenty-five minutes carrying a silt concentration of between 1000 and 2500 p.p.m.

The problem was studied at the station on a 1/60 scale model, which faithfully reproduced the salinity/density current phenomenon. The effect of the passage of a tanker through the lock on the density currents was investigated and possible remedial measures were tested. In order that the effect should be repeatable in the demonstration model, coloured salt water has been used. The difference in density between the two fluids is only 2 per cent.

Remedies so far suggested include reducing locking periods, if at all possible, and reducing the fresh water inflow to keep the dock as saline as practicable. Another alternative, investigated so far at the model scale, is to interpose a screen of air bubbles in the manner of the air breakwater. Investigation of the scale effect of this proposal, which is effective on the model, is in progress.

### Bridge Over Ankobra River, Ghana

This bridge, a model of which is shown in the illustration, is part of a road scheme for the coastal area of Ghana. Site investigations disclosed great thicknesses of soft sand and silt necessitating a structure with a single clear span of 275ft. Proximity to the sea makes concrete the preferred material for minimum maintenance. The superstructure consists principally of a suspended span carried by double cantilevers supported on " cradles " and counterbalanced by the concrete-filled overhanging abutments. The foundations are on long piles.



**Model of prestressed concrete road bridge over the Ankobra River, Ghana**

The illustration well shows the trapezoidal shape of the two " cradles ". Piles are grouped under the two low corners of each trapezium, and the cradle structure is to be built up in reinforced concrete, the shuttering for which necessitates no staging in the river, the formwork being supported from the pile caps.

The cantilevers consist on both sides of three beams, 145ft long and 8ft 8in wide, the depth being 10ft 9in maximum tapering to 3ft 6in. These cantilever beams are cast as open boxes with transverse webs. They are cast partly onshore, with the central (i.e. deepest) point of the beam, which is shown in its ultimate position at the outer edge of the cradle in the illustration, positioned just about over the abutment of the bridge. The centering is carried partly by strutting from the top of the cradle, and partly by a ramp, which continues the slope of the top of the cradle up over the abutment. When the beam is cast and matured, it is slid down the slope to its ultimate position, the cradle and beam having alloy steel beaming rails and pads, respectively, for this operation, the rails in the cradle being carried on upstand ribs.

Post-tensioning cables going from the beam soffits over the tops of the transverse webs along the top of the beams and tying down to the abutment structure are next installed and stressed as the beams are loaded up. Finally, the whole cradle and beam complex is made monolithic by pouring *in-situ* concrete between the main beams.

The midspan section consists of three simply supported precast box beams 80ft long, 3ft 6in deep, lowered in position from a temporary construction bridge previously launched between the tips of the cantilevers. The box beams are tied together transversely by the *in-situ* road slab. The walkways are made in 5ft long precast sections cantilevered off the main structure.

The model was exhibited by Messrs. Ove Arup and Partners.

### " Moby Dick "

A model of a proposed nuclear-powered submarine freighter called " Moby Dick " was exhibited by Mr. H. D. Watson. The proposed submarine has been the subject of a design study by Saunders-Roe, Ltd., which was commissioned by Mitchell Engineering, Ltd. The study concentrated on the feasibility of using such a vessel for carrying iron ore from the Canadian deposits at Ungava to the U.K., or for similar duty. She would have a 150MW (thermal) boiling water reactor, a design speed of 25·5 knots at a depth of 300ft, and a displacement of 50,000 tons, giving a deadweight carrying capacity of 28,000 tons.

The performance and economics of the vessel have been investigated thoroughly, and the proposal is clearly practical from the technical point of view. It is pointed out, however, that at the moment such a project would not prove as economical to run as a surface ship, conventionally powered. In the opinion of those responsible for the project, in five or ten years' time the economic balance will have changed in favour of such vessels as the proposed " Moby Dick," and experience of their use should be built up.

### Heat Metering Computer

A simple mechanical analogue computer, designed to solve problems connected with the heating of buildings, was exhibited by Mr. C. C. Champion, chief mechanical and electrical engineer of the War Office and Directorate General of Works.

The heating requirement of a building is normally calculated assuming steady state conditions, but in practice the conditions are far from steady. The computer takes into account variable weather conditions and heating programmes and makes allowances

for the time lags associated with the thermal capacities of the structure and of the heating element. Provision is made for two variable inputs, one representing outdoor temperature and the other the heat input to the building. The output pointer then indicates indoor air temperature.

An alternative use of the computer is to calculate the output from a heating system. In this case the two inputs represent the rate of flow through the system and the temperature difference between flow and return. The output pointer then indicates the instantaneous rate of heat transfer and a Veeder counter indicates the integrated total heat transfer.

The instrument performs these calculations simply and quickly whereas attempts to analyse the data by arithmetical methods are tedious and time consuming.

# Augmentation of the Water Supply of Hong Kong

*The rapid growth of population in Hong Kong has presented very difficult problems in building up an adequate water supply. A paper, entitled as above, and written by Mr. G. A. R. Sheppard* was presented for discussion last week at the Institution of Civil Engineers' conference on civil engineering problems overseas. Here we abstract Mr. Sheppard's description of two unusual projects, namely, the design of an undersea pipeline, and an investigation of the conversion of an arm of the sea into a fresh-water reservoir.*

THE dry-season water demand of Hong Kong was 26 m.g.d. in 1946 and it is estimated that by 1971 it will be 142 m.g.d. Since the second world war, the problem has been made even more difficult by the very rapid increase in population from about 1,800,000 to approximately 2,700,000, an increase of about 50 per cent in thirteen years.

The Tai Lam Chung scheme was proposed before the war and a decision to proceed with it was made in 1951 ; the work was brought into supply in 1957. This reservoir has a capacity of 4500 million gallons and a total catchment area of about 12,000 acres, giving a winter yield of 22 m.g.d. Before the completion of Tai Lam Chung it became obvious that the demand would soon outstrip the yield, and in 1954 various alternative sources were investigated. The decision was made in 1958 to proceed with the Shek Pik reservoir scheme on Lan Tao Island, which would add 5350 million gallons to the total storage capacity and 8062 acres to the total catchment, increasing the winter resources by 27 m.g.d. Work on this scheme began in 1958 and is due for completion in 1963.

By the time the Shek Pik scheme is completed the winter demand will again have outstripped the available supply ; so in 1958 the Government suggested that two areas of sea should be enclosed by dams built in the sea ; then the resulting salt-water lakes pumped out and filled with fresh water. This very original idea appeared to be promising, but it was obvious that a very full and costly site investigation would have to be carried out before definite proposals could be made. It was decided that feasibility reports, based on a few borings in the sea-bed along the lines of the dams, should be made.

The report on the Plover Cove scheme showed that it would provide a reservoir with usable storage capacity of 29,000 million gallons and a yield of 55 m.g.d. The Hebe Haven report was first prepared on the basis of a top water level no higher than maximum high tide in order not to inundate villages and agricultural land. The result was not very satisfactory and a further report was made using a top water level 12ft above high tide. This provided a usable storage of 3900 million gallons and a yield of 20 m.g.d. The Government has since given instructions for the full investigation of the Plover Cove scheme and is considering the Hebe Haven report. The Government is also investigating the economics of sea-water distillation, using atomic power, and the decision as to whether the Plover Cove and Hebe Haven schemes shall proceed to construction will depend on the eventual comparison of costs.

* Partner, Messrs. Binnie, Deacon and Gourley

### Thirty-inch Diameter Undersea Pipelines

An interesting feature of the Shek Pik scheme is the twin 30in diameter pipeline to be laid in the sea-bed between Silvermine Bay and Sandy Bay, Hong Kong. A survey of the sea-bed, including the testing of samples recovered, together with measurements of tide, was carried out in the dry season 1958-59, and since then the contract for laying the pipelines has been put out for tender. Except at the 100ft deep Lamma Channel adjacent to Hong Kong Island, the pipelines will be laid in fairly shallow water at an average depth of 25ft. The lines will be cross-connected in the shallow water near Chau Kung Island, giving two lengths of roughly 3 miles and 5 miles. The pipes will have to be sunk into the sea-bed to give protection during typhoons, against movement of the sea-bed, and against damage caused by ships dragging anchor.

The pipe will be of ½in steel, lined with epoxy resin and sheathed with resin-bonded glass fibre and pipeline enamel. Concrete casing will give the required negative buoyancy. As the tenders for laying are not due until June, 1960, it is not at the moment possible to say whether the lay-barge or towing method will be adopted. With the lay-barge, the individual pipes, or possibly strings prewelded to 100ft lengths, will be welded to the previous length and, after making up the internal lining and external concrete at the joint, fed over the stern. This, of course, entails the floating craft being at sea for a long period. If the towing method is used, all the pipes will be site-welded into long strings on shore before towing commences. When one string has been dragged out to sea the next string is welded on to the shore end and towing is continued. An essential for this method is a sufficient area of flat land adjacent to the sea on which to prepare and store the long pipe strings ; unfortunately, there is no very convenient site available.

All circumferential joints, both on site and at the manufacturer's works, will be 100 per cent radiographed. The completed pipelines will have cathodic protection by impressed currents at both shore ends. The estimated cost of the scheme is about £10,000,000, and the cost of water delivered to Hong Kong Island is about 1s. 10d. per 1000 gallons. The catchwaters and all the works on Hong Kong Island are being carried out by the Public Works Department.

### Plover Cove Scheme

A full investigation for this scheme is now being undertaken. This may result in more convenient and economic locations of the ancillary works, but the general principles of the scheme will not be altered. The reservoir will have a top water area of 2750 acres, a bottom water area of 2110 acres, and a usable capacity of 29,000 million gallons. The direct catchment of 6950 acres (including the water area) and the indirect catchment of 14,400 acres will provide an average inflow of 68·4 m.g.d. The evaporation loss will amount to 8·4 m.g.d. so that the net available input is 60 m.g.d.

A steady yield of 55 m.g.d. can be obtained. Alternatively, by adopting a regulation rule in which the average yearly extractions would vary from 65 to 45 m.g.d. a long-term yield of 59·5 m.g.d. can be obtained. This rule has been worked out on the rainfall records of 1888–1939, during which period the reservoir would have overflowed five times and, on two occasions, reached minimum water level. The long-term rainfall is 85in per annum.

The main dam will be 6400ft long across the western end of Plover Cove in a sea depth of about 35ft. The sea-bed consists of about 40ft of soft mud overlying the decomposed granite. As this mud forms a watertight seal on the bed of the reservoir it is necessary to leave about 5ft of it *in situ*, and the proposal is to dredge out 35ft of mud over an area extending well beyond the toes of the dam and to dump large rocks, which will sink into the remaining 5ft, and so form a solid foundation for the dam.

The dam will be composed of outer bunds of rockfill and an inner zone of impermeable decomposed granite, and will contain about 10,000,000 cubic yards of material. A full-scale experiment of dredging, rock-dumping, and placing of core material is being planned; borings to be put down through this experimental " bank " will show how well the rock settles into the mud under load, and will enable the permeability of the core material " as placed " to be measured.

The top water level will be 23ft above M.S.L., and the minimum operating level 20ft below M.S.L. The dam will, therefore, have to retain water in either direction, the lowest drawdown level being fixed so that, for the greater part of the time, the seepage tendency will be outwards. In the typhoon of 1937 the sea level in Tolo Harbour built up for several hours to a level 16ft above M.S.L. To allow for a repetition of such an event, plus wave action, the design level of the top of the dam is 30ft above M.S.L., with a wave wall up to 33ft M.S.L. Two short dams will also be required joining the small islands at the southern end of the main dam to the peninsular, forming the southern side of the reservoir. These dams will be constructed as overflows.

Full site exploration of the dam foundations and possible borrow areas is now in hand, and a grouting and permeability test will be carried out on a narrow neck of the southern peninsular. Tests will also be made to ascertain the amount of salt which will be leached out of the mud when in contact with fresh-water. As only 460 acres at present below sea level—out of a top water area of 2750 acres—will be exposed at minimum water level, the problem is not so severe as if the reservoir were to be drawn right down and the full area gradually subjected to wave action as the water level fell.

It has been assumed that after the initial pumping out of the sea-water the inflow

and direct rain of the next wet season would also have to be pumped out before the water could be usable for potable purposes on refilling. The permeability and stability of the dam will be more severely tested, with the inside water level down to nearly 40ft below M.S.L., than it will ever be when the reservoir is in use.

In order to bring in the 14,400 acres of indirect catchment area, about 20 miles of tunnel, from 11ft to 30ft unlined diameter, will be required. In the scheme originally envisaged, the water could be abstracted at an intake near the north end of the main dam and pumped through two 48in diameter submarine pipelines to a treatment works situated on the hill above Tai Po. From the treatment works the water would gravitate through two 48in diameter pipes to a 40,000,000 gallon low-level storage reservoir near the railway tunnel at the south end of Sha Tin. A pumping station at this point would lift the water by pipeline and tunnel through Beacon Hill to a 20,000,000 gallon service reservoir at 500 O.D. on the south side of the hill for distribution into Kowloon.

An alternative arrangement is being investigated for making the main catchment tunnel operate as an outlet, as well as an inlet, and for continuing it in a southerly direction to the end of the Sha Tin valley where the treatment works would then be situated. This layout has the disadvantage that, in times of flood, unsettled water would be delivered to the works and extensive sedimentation tanks would be required. As the treatment works will have to deal with 60 m.g.d. (or if the abstraction rule is adopted, 65 m.g.d.) a considerable area of flat ground would be required. It may, however, prove to be the more economic layout. Site exploration on the proposed tunnel lines and possible treatment works, and reservoir sites is now in progress.

The estimated capital cost of the Plover Cove scheme is £22,000,000, and the cost of water delivered at 500 O.D. 1s. 9d. per 1000 gallons, based on a yield of 55 m.g.d. It could be completed by about 1968.

The consulting engineers for these proposals are Messrs. Binnie, Deacon and Gourley.

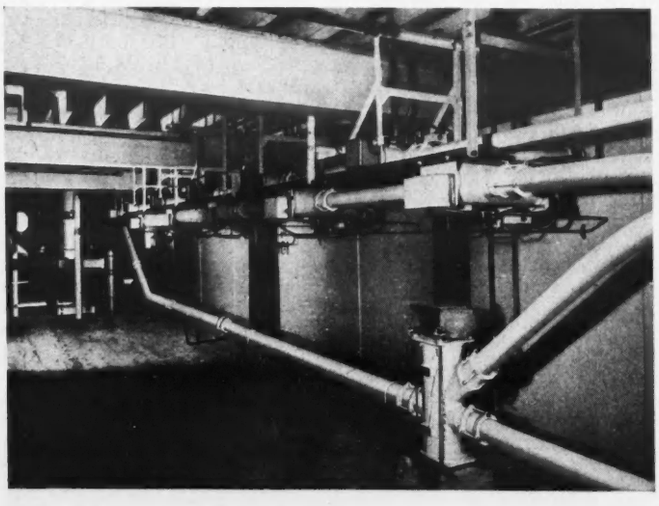
# Bulk Handling and Automation at Biscuit Works

*Present-day economics in the manufacture of biscuits have called for considerable modification of current practice and Carr and Co., Ltd., has nearly completed a major reconstruction programme. This includes the bulk handling of flour and other ingredients, together with the introduction of automatic control through the medium of a punched-card system.*

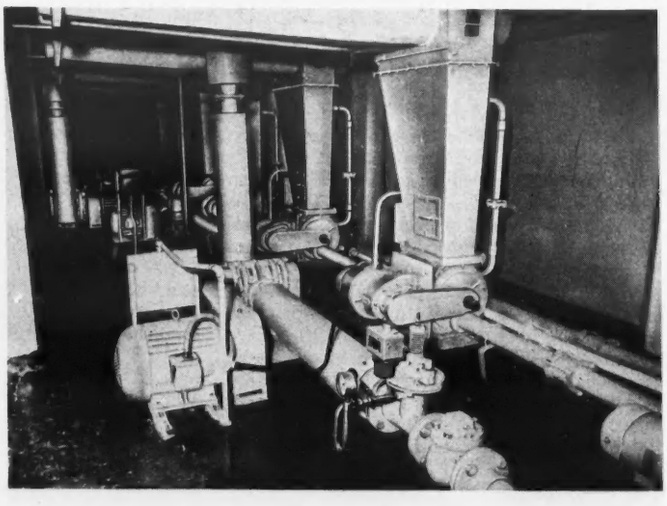
TO meet the present-day tempo of production and to effect economies in manufacture, Carr and Co., Ltd., embarked on a reconstruction plan which included the bulk handling of ingredients. Although land was available it was decided to install the new equipment within the present site, a decision which involved the solution of many problems in reconstructing the fabric of old buildings to accommodate new machinery. Such problems are a corollary to a firm having been in existence for a long time, since 1831 in this instance, in that the replacement of old by new techniques often means a complete changeover in the production flow. The scheme, evolved to satisfy the rapid changes in the biscuit-making industry and present-day commercial economics, meant the designing of an installation for the bulk storage and handling of ingredients, and this objective has been achieved by the joint efforts of Thomas Robinson and Son, Ltd., Rochdale, Elliott-Automation, Ltd., London, and Baker Perkins, Ltd. Thomas Robinson and Son, Ltd., was responsible for the bulk flour installation, while Elliott Brothers (London), Ltd., a member of the Elliott-Automation Group, provided the controls and installed the central control panel. Now the company has moved towards full automation in biscuit manufacture and road tankers deliver flour, glucose, syrup and sugar into storage tanks from which they are conveyed under automatic control to mixers and finally as dough to the ovens. Control is by a punched recipe card system and a master control panel, by means of which the correct quantity and variety of flour is forwarded, while pre-set digital controls ensure the delivery of the required quantities of fat, syrup and glucose.

### Flour Handling Equipment

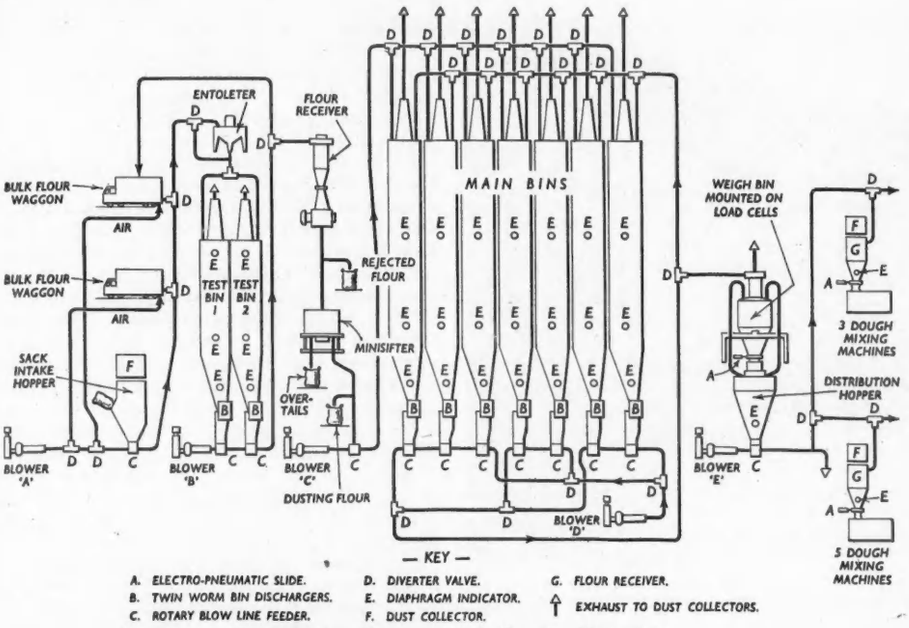
Flour in bulk or in bag can be handled by the plant, which has been tailor-made to Carr's requirements and to fit into existing buildings. Overall control is from a panel which incorporates a punched-card system and print-out facilities to record the day's work, and can be completely automatic or semi-automatic to allow for close-downs in particular sections. Our flow diagram shows in simplified form the arrangement of the bulk flour handling plant. At ground floor level there are two bulk intake points through which the tankers are discharged by their own blowing units or by a dock-based unit, the discharge rate being 18 tons per hour. Discharge is into any of two test bins, each having the capacity of one vehicle load of 15 tons, from where, upon acceptance, the flour is transferred to one of seven storage bins; if rejected the flour is returned to the lorry or is sacked by a return blowing line. Flour, as already mentioned, can be delivered in sacks and is passed through an entoleter, where any non-virus organisms are removed by centrifugal action, before being blown to the test bins at a rate of 5 tons an hour. The main silos have a capacity of 31 tons, are each 47ft in height and have been installed in the existing granary building. These Tyler flour bins combine the advantages of timber for flour storage, including good insulation and freedom from condensation, with the strength of a reinforced concrete framework. However, before being blown to the main storage bins the flour from the test bins is given special treatment, being redressed in a minisifter. The transfer operation is remotely controlled and pneumatically-operated diverter valves direct the flour stream from the main conveyor line into a selected bin. These valves have a cast iron casing, one inlet and two outlet bores and a solenoid-operated piston valve which admits air to the required cylinder end so that the stock passes through the appropriate outlet bore. Other operations carried out in this section of the plant include the delivery of flour, for dusting flour purposes, to a bagging point, delivery of flour to a reject bagging point or back to the vehicle. All movement is under the control of the central panel, where a switch enables the controller to select the operation required and a button starts the necessary motors in their correct order. When the flour is flowing



Return line to main storage bins



Blowing units and twin worm dischargers below main bins




**Simplified flow diagram of bulk flour handling plant**

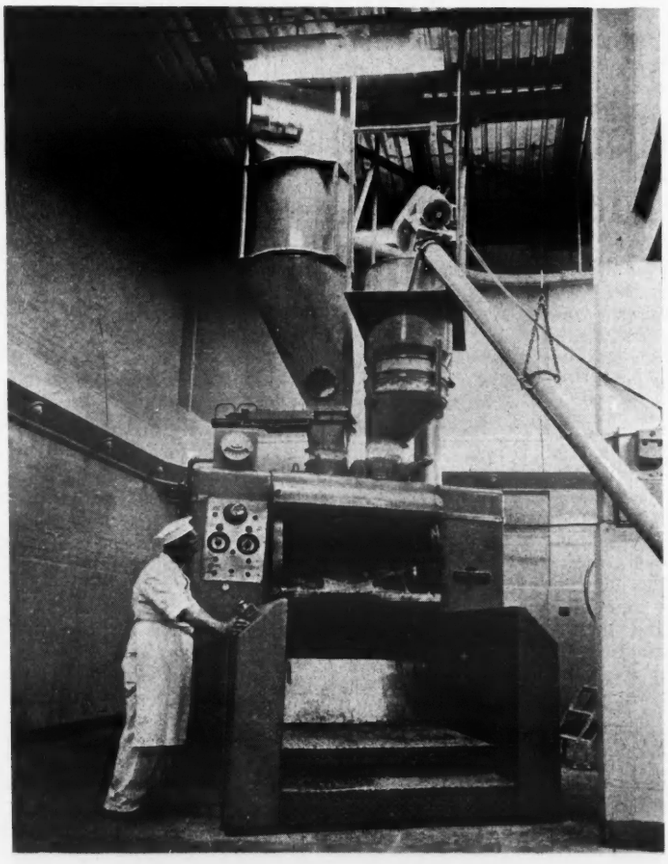
this is indicated by a light, actuated by a pressure switch; then the starter button can be released and the operation continues automatically and closes down automatically when the flour ceases to flow. The section is fully interlocked so that blowing cannot be started if the bin selected for delivery is already full or the correct route is not set up. Arching of the flour in the bins is prevented by indicators, fitted at three levels, which automatically introduce, through the medium of solenoid-operated valves, compressed air to break down any arch of flour.

Discharge from the bins is by means of twin worm dischargers which feed the flour into intermediate hoppers mounted directly above blow-line rotary feeders. These have been designed to feed powder material into high-pressure conveying lines without excessive loss of air, and consist of a casing carrying a chain-driven multi-bladed rotor. Material is fed into the sectors between the blades and discharged at the bottom of the casing, where are the inlet and outlet ports of the blow-line. Air remaining in the sector is discharged through a neutralising port to prevent interference with the entry of stock. Diverter valves introduced at strategic points in the conveying line permit the conveying of the flour selected to the batch weigher. Our illustrations show the return line to the main bins and the blowing units, together with the twin worm dischargers below the main bins.

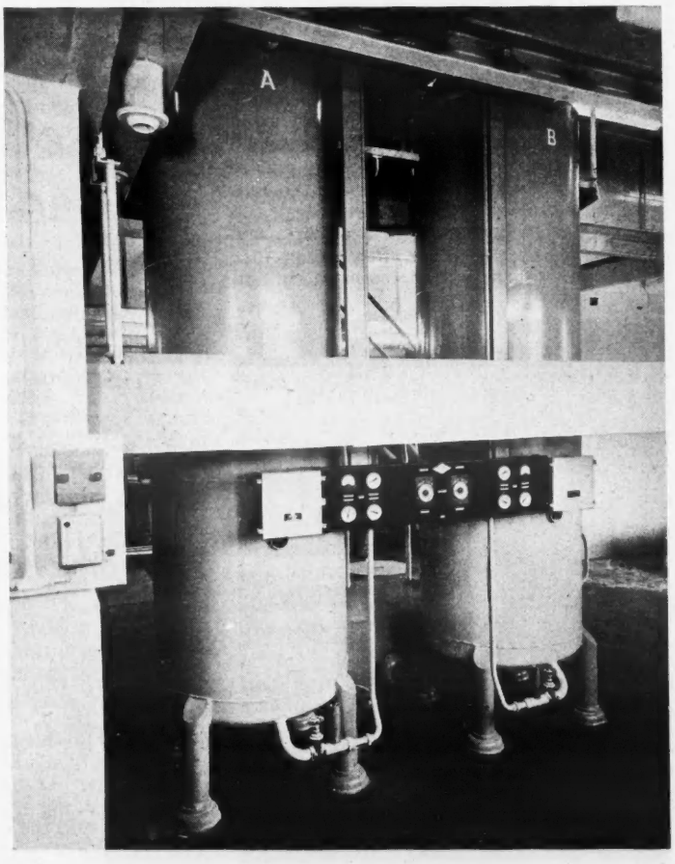
### Batch Weighing and Distribution

The batch-weighing bin, mounted on Elliott load cells, weighs up to a maximum of 800 lb and each batch may consist of various quantities of flour from the seven bins. By means of a punched recipe card the correct weight of each particular flour is delivered, the director valve automatically switching over when the selected weight has been attained, while the wheel valve below the storage bin is automatically stopped. Any flour in the line is returned to point of origin. When the batch of flour is made up, an electro-pneumatic slide is opened to discharge the flour into a distribution hopper at the base of which is a rotary feeder supplying the conveying line through which the batch is directed to the receiver located above the dough mixer requiring the supplies, as controlled by the automatic programmer and the punched-card system.

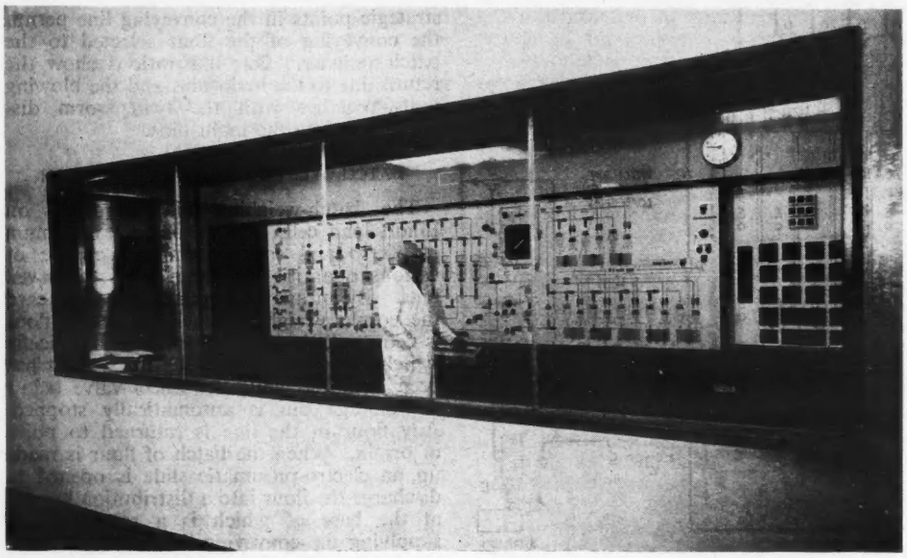
Control can be by manually programmed or pre-programmed systems. The latter uses punched recipe cards, in which the holes correspond to the weight of each ingredient, to give automatic operation. Plugs inserted through these holes into the programme panel interconnect two printed circuit matrices, so selecting the required ingredient and its correct weight. Requests for a mix originate from the oven operator, who presses the appropriate button and so actuates the programmer which, in the event of more than one request at the same time, scans all the ovens in a set order until it finds one making a request. It then selects



**Bowl mixer surmounted by flour receiver and sifter unit**




**Pressure vessels for storing plastic fat**



**Master control panel for bulk flour handling with punched card recipe section at the right**

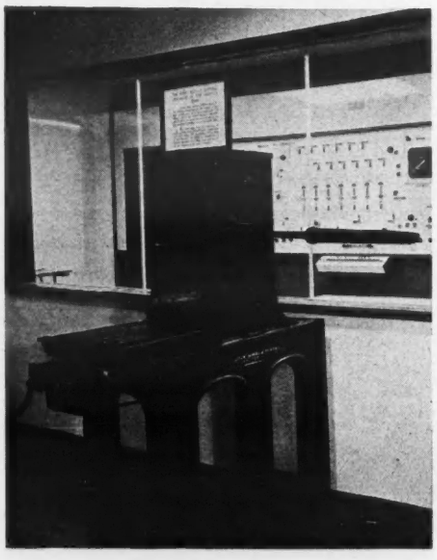
the recipe for that particular oven and initiates the supply of each ingredient to the receiver above the mixer. When weighing and dispatching operations are completed, the programmer hunts for another oven making a request.

The system includes a number of safeguards and the programmer will ignore a request from an oven where the containers already hold ingredients or have their discharge valves open ; similarly, it will reject a recipe for which all the ingredients are not available. However, when the deficiency is corrected the request is automatically made available to the scanner again. When the automatic cycle is in progress all starting buttons and selector switches are rendered inoperative. A signal by a comparator stops the feed into the weigh-hopper when the weight equals that required, and compensation is made at subsequent weighings for any overshoot. A complete record of ovens supplied and weights of ingredients forwarded are given by a teleprinter and the latter figure, which is cumulative, gives a check on stocks. Provision is made in the system for the controller to transfer flour from one hopper to another to facilitate maintenance work, and also to turn over the flour after long periods of storage so that safer temperature and humidity conditions are restored. The control panel, seen in our illustration, is mounted in a dust-free air-conditioned room and the starters are grouped and placed in a compartment behind the panel.

### Production

The batches of flour, as already described, are delivered to receivers, each with its own dust collector, mounted above the mixers, one of which, a Baker Perkins high-speed tilting bowl unit, is illustrated herewith. The mixer is fed with other ingredients by means of "Ajax" worm elevators over the hopper, which is a Dallow-Lambert "Dustmaster" unit. Also conveyed from the central warehouse are the supplies of sugar which have been ground there and which are received in bulk but are not as yet handled by the new plant. Nearby are two glass Pfaudler tanks, each of 15 tons capacity, one for syrup and one for glucose, and each is supplied from road tankers. There are also two 3-ton capacity, Lithcote-lined, cylindrical-pressure vessels, shown in our illustration, which contain plastic fat which has been pumped a distance of 450ft from the central fat processing plant through a stainless steel pipe which is water-jacketed and through which water, at a controlled temperature, is pumped at high speed. The fat containers are also water-jacketed, the jackets having spiral guides to ensure even distribution of heat. Coemt positive pumps, controlled by "Sodeco" digital counters mounted in the control room, deliver metered quantities of syrup, glucose and fats to the mixers through pipes, of which some are resistance heated. The mixers incorporate timing controls which can be fore-set to govern the period of high- or low-speed running. The mixing room is equipped with air conditioning, designed by the company's own engineers, which can maintain an even temperature of 65 deg. Fah. On completion of the mix it is discharged into a hopper in the floor leading to the associated cutting machine below.

Having inspected the installation for the bulk storage and handling of ingredients, opportunity was taken to make a tour of the works to see various cutting machines and band ovens, including one which is 236ft in length. Various classes of biscuits were observed in the course of manufacture as well as the preparation of a variety of fillings and coatings. Wrapping and packaging sections were visited and of particular interest was the museum where models of early biscuit-making machinery and ancillary equipment were in view. Our illustration shows the first biscuit-cutting machine, which was based on an old pattern hand printing press, and invented in 1849 by Jonathan Dodgson Carr who founded the company in 1831.



**First biscuit-cutting machine made in 1849**

# Association of Mining Electrical and Mechanical Engineers

*The annual convention of the Association of Mining Electrical and Mechanical Engineers, which was held at Blackpool last week, marked the completion of fifty years active work directed towards increasing the efficiency, safety and productivity in the coal mines of this country. This "Golden Jubilee" convention was attended by some 700 members and guests and the well-balanced programme included the presentation of some interesting papers and visits to works in addition to a number of social functions.*

THE annual convention of the Association of Mining Electrical and Mechanical Engineers at Blackpool last week opened with the presidential address by Mr. A. E. Crook (Chief Engineer (Production) of the National Coal Board), who took for his subject electrical and mechanical contributions towards efficiency and safety in the coalmining industry during the past fifty years and the further contribution which may in the future be made by engineering. In the year the association was formed, said Mr Crook, there were some 3200 mines in this country producing nearly 264 million tons annually, of which about 5 per cent was cut mechanically. At that time there were about 1700 coal-cutting machines of all kinds in use and by 1959 the number had increased to 9000, but the proportion of the total output obtained by machines increased from 5 to 90 per cent—or from about 13,000,000 to 176 million tons. This corresponds to an increase in annual output per machine from some 7750 tons to 19,600 tons. Further, the output of coal cut and loaded by machinery had advanced from only 0·3 per cent as recently as 1943 to 32 per cent or 72,000,000 tons in 1959, at the end of which year there were more than 800 armoured flexible conveyors in use at the coal-face. This type of conveyor provided the basis for a prop-free front and a completely mechanised system both for constantly maintaining maximum roof support and advancing the conveyor, which enabled both coal-getting and face transport to be entirely changed.

These revolutionary results had been achieved by more and better machinery and an increase in the total horsepower used at the coal-face from an estimated figure of 40,000 in 1909 to about 800,000 in 1959. In the same period the use of compressed air

for driving coalcutters had declined from about 60 to 10 per cent in favour of electricity. During the past fifteen years there had been a revolutionary change in the method of supporting the roof at the coal-face, where now there were more than 750,000 hydraulic props and eighty-five completely mechanised hydraulic roof-support systems which are advanced while the roof is being supported. The miner now had " power to his elbow " through machines which were rapidly removing drudgery and thereby promoting higher productivity, efficiency and more congenial conditions at the face.

Mr Crook then dealt in detail with the subject of safety in mines and the decline which had taken place in the number of accidents generally attributable to electrical and mechanical equipment connected with shafts, haulage, transport and machinery above and below ground. In dealing with the future contributions engineering could make to the efficiency and safety in mines, he said that, as in other industries, the requisite technological advances will greatly reduce the ratio of non-technical workers to professional engineers, technicians, craftsmen and technical operatives. There would be more and more difficult problems which would not be solved without the specialised knowledge of these engineers, while at the same time the complex apparatus would require the intimate knowledge of the technicians and the craftsmen for its installation and maintenance and that of the technical operatives for its proper operation. Thus the technical group would continue to grow in importance and require appropriate education, qualification, selection, training, organisation, status and co-operation. There was no doubt that such advances would make a great contribution towards safety by using the best apparatus together with the highest practicable standards of inspection and maintenance and by drastically reducing the number of men at risk in mines.

The twelfth " W. M. Thornton Lecture " was presented at the conference by Mr. B. L. Metcalf (Director of Engineering for the National Coal Board) and in the abstracts which we give below there have been selected for mention two of the many new pieces of equipment recently introduced or under development which were described in the course of the paper.

### Technology and the Future

Up to the the end of the last war the mining industry had not taken full advantage of technological development owing mainly to the impact of the first world war and the many political and economic upheavals which followed in its train. This is not to overlook the remarkable developments which did take place in some coalfields and the great progress which was made by some manufacturers in developing new machinery and apparatus. Advantage of these applications was, however, only taken by a limited number of colliery companies and even to-day our best achievements are being made on a narrow front.

Indeed, in the application of the mechanical and electrical sciences to mining there is no limit to the variety of techniques, many of which are already in use covering the whole range from light-current electrical engineering involving modern techniques of communication to large and formidable machines. With all these new techniques there is a change in the nature of the skills required. The skills to-day are in the creation and servicing of machines to take the drudgery out of man's work, to increase his productivity, and to make the conditions of work safer and more attractive. They lie in the development of production processes and of suitable machines, on the one hand, and in installation, operation, the reconditioning and proper maintenance of these machines, on the other.

Industrial research in an operating industry covers the investigation either by laboratory techniques or by systematic observation on working plant of the properties and behaviour of the tools used, the efficiency of the processes adopted and the suitability of the machines to carry out these processes.

Technical progress does not always require the application of new scientific knowledge. The cheapest and quickest way to achieve technical progress is to use the knowledge which already exists and to improve existing machines step by step.

In connection with the work of prospecting for coal a nucleonic logging probe based on a gamma ray back-scattering technique has been devised by the N.C.B. Mining Research Establishment to locate the position of coal seams in a bore-hole. The probe carries a radioactive source and a detector. When it approaches the interface of a coal seam and the adjacent stratum, the amount of radiation scattered back to the detector changes and this can be indicated by a suitable counting circuit. Tests in surface bore-holes to depths of 3000ft to 4000ft have indicated that it is possible to locate the seam boundary to an accuracy of approximately 3in.

The probe unit could be used underground to explore new workings as roadways are being driven out, and as it is only 1·5in in diameter it could be lowered or pushed into the holes drilled with standard underground drilling equipment. Similarly, if a face should disappear owing to the occurrence of an unexpected fault it would be possible to locate the seam by drilling a number of shot-holes at different angles and inserting the probe into each one in turn. In practice the only limit to the range of this device would be the length of bore-hole which could be drilled and kept open long enough for insertion of the probe.

[The paper then goes on to deal briefly with developments in shaft sinking and tunnelling, winding, methane drainage, coal face machines, hydraulic transport, communications, &c.]

The completely man-less face has long attracted the mining engineer and is an objective to the attainment of which mechanical and electrical engineers are applying themselves. To achieve this one of the most difficult problems is to get the power-loading machine or plough to steer itself. A " coal-sensing " probe has been devised by the N.C.B. Mining Research Establishment (M.R.E.) to help to guide power-loading machines. These probes use a measurement of the intensity of gamma rays scattered back from the floor of the coal seam to determine the thickness of coal left on the floor by the machine. In one application the machine will have a sensing probe in the leading end of each of the two skids on which it runs. The probe units are to be connected to individual meters (calibrated in inches of coal) at the rear of the machine, so that the operator can tell at a glance if the machine is tending to cut into the roof or floor at either side, and correct any such tendency by means of the four hydraulic jacks connecting the body of the machine to the skids. It is hoped to try out this equipment at New Lount Colliery (N.C.B. East Midlands Division) this year. Once the principle has been proved underground by these trials it is intended to take the obvious next step of using the signals from the sensing probes to control the jacks automatically.

To help with its specialised problems the mining industry must harness for its own benefit the vast range of improvements being made in allied fields—in metallurgy ; in the use of man-made fibres and other synthetic products ; in mechanical and electrical machine design ; in instrumentation ; in communication ; in the medical field ; in the use of electronics and hydraulics ; and so on. An interplay of technologies is essential to rapid progress.

A rapid advance in technology on the production side needs good technologists, good mining-mechanical and mining-electrical engineers, good mechanics and electricians of the mine, good craftsmen. All the new and complicated machinery and apparatus must be well maintained, safe to operate, reliable, efficient and suited to its purpose. There must be a strong and adequate engineering organisation to back up the mining operations. Information must be accurate and readily available, communications must be improved and there must be a proper assessment of costs so that the value of any new technological advance can be accurately predicted.

Machines without the men to look after them who understand both their purpose and the principles on which they operate are merely a costly encumbrance. The Association has a great part to play in guiding the education and training of these men and in stimulating their desire to improve their scientific and technical skill.

Two papers were presented at the conference by overseas contributors—" Mechanical and Electrical Maintenance at the Netherlands State Mines " by Jr. W. E. Van Os and Jr. M. B. J. Kneepkens ; and " Organisation of the Engineering Services at a Modern German Colliery " by Dr. E. Anderheggen.

The conference concluded with an address by Sir James Bowman, chairman of the National Coal Board, who congratulated the association for its services to the mining industry, and on so successfully achieving its objectives of increasing the efficiency and experience, and improving the status, of its members during the past fifty years. The coal industry to-day had reached what he considered to be one of the most critical stages in its history, and it would be the efforts of management and men in the industry that would determine the direction it would take in the future. The principal task during the past three years had been to bring production into balance with demand as rapidly as possible, without dangerously running down the capacity of the industry, and without inflicting widespread and serious hardship on the mining communities. Despite all the conflicting problems this aim had been achieved by the end of 1959, and this year production and demand were in balance. A net reduction in stocks would be made this year and next year, and in future years production policies must be regulated to the trend of demand, in order to make a progressive reduction in coal stocks.

A market for 8,000,000 tons of small coal had been lost this year, because the electricity industry built and converted stations to burn oil, as a result of Government pressure five years ago, at a time when it was feared that there might be a shortage of coal. Those oil-burning stations would in due course die out, and in the long term power stations would provide a major, expanding, outlet for the consumption of more coal. In 1965 power stations were expected to need 55,000,000 tons of coal, compared with 46,000,000 tons last year, and power stations' requirements of coal would probably go on rising for some time after that.

# LETTERS AND LITERATURE

## Letters to the Editor

### RULES AND REGULATIONS FOR STRUCTURAL STEELWORK

SIR,—In your issue of April 22, you have published an article on the above topic by Mr. Procter which represents the latest British Standards Specifications on steelwork design as handicaps that preclude the shackled designer from producing competitive structures. This contention cannot be allowed to pass unchallenged.

These specifications are prepared by committees comprising distinguished representatives of all branches of the industry, the research organisations and the universities who are in contact with all the latest developments in theory and practice. At all stages of their preparation every effort is made to derive a basis for design based on the fundamental characteristics of each type of component and material and the information is distilled into design rules simple enough to be acceptable to the busy designer without undue sacrifice of economy. Moreover, the drafts are circulated to a wide range of interested persons for comments. These are subsequently carefully scrutinised and any rational proposals are incorporated in the final version. Thus, contrary to hindering design, these documents offer the designer a condensate of the most advanced data that are available at a given time. Few engineers would have the breadth of understanding or the time to keep abreast of developments in the same way. Moreover, there is nothing to prohibit a designer from using additional research data when preparing an advanced scheme.

Referring to the detailed items discussed, we agree that some freedom of choice of load factors is desirable and has indeed been recommended by the Structural Safety Committee of the Institution of Structural Engineers. Their report seems to have been forgotten and will only be revived under pressure from designers. It is therefore a pity that Mr. Procter asks for guidance on load factors for use with " plastic " design which would surely be a further impediment of the kind that he advocates should be abolished. Strut formulæ represents a bone too old to be chewed further. However, it would be interesting to know how Mr. Procter derives his load factor of 3·0 for an $l/r = 100$. Furthermore, the effective lengths obtained from theory and laboratory tests bear little relation to those obtainable in an entire structure. The existing coefficients are known to prove satisfactory from failure tests on full-scale structures and other than by solving the stability problem for an entire framework (which few designers could or would undertake) there is little scope for improvement.

Mr. Procter's comments on steel frame design are ironical. It may be recollected that in the mid 1930s after many years of the most painstaking analysis and research, the Steel Structures Research Committee produced a rational basis for designing semi-rigid frames which was rejected by practising engineers because the design process was too time consuming for the small economy achieved. The methods subsequently accepted and given in the final report were derived after considerable simplification at the expense of efficiency !

The author has stated that the rules for beams and girders are " based on ideas that are quite out of date " and quotes as reference a paper of his own published twenty-three years ago. His discussion of the new rules ignores the considerable progress in this field since then. His comments on flange warping, top flange loading, the effect of riveted flanges and the use of the beam depth/flange thickness ratio suggest that he has not seen the paper presented to the Institution of Civil Engineers setting out the basis for these rules, which discusses all of these topics.

Perhaps even stranger is the complaint that the design of laterally unsupported beams " was formerly a matter of a simple formula " but " now it has become a complicated affair of tables and rules." Does the author want to return to the simple rules ? Does he really believe that such complex matters can be closely approximated by simple rules ? Such a complaint would be understandable from one who wants a quick, slick, basis of design at the expense of economy, but is it a relevant argument in support of greater freedom to use the latest available technical improvements and data ?

We agree that the combined stress clause could perhaps be improved. The theoretical basis for estimating combined stresses is well known but is more complex than Mr. Procter's over-simplified formula, in which, for example, the terms $p_c$ and $p_1$ should surely be the factored elastic buckling stresses for struts and beams and not the permissible stresses for imperfect members. Rules based on rational theory would necessarily be more involved, however, and the economy that might result from a modification remains to be determined.

To those who may feel inclined to wish themselves free of the restraints of the standards it is worth asking if they would consider whether they are in a position to develop a more advanced, rational and swift basis for design than is offered by the " regulations," bearing in mind that much research and investigation into the application of a new theory is essential before it can safely be adopted and that many of the rules of a standard are interdependent.

There is no doubt that the new specifications compare very favourably with those of other countries and that a competent designer using them would be at no disadvantage in competition with foreign standards. To assert, as Mr. Procter does, that " all designers are obliged to design heavy, unshapely structures that are unpleasing to the eye, uneconomical and often quite uncompetitive " is to slight the British designer and not the British Standards.

A. R. FLINT, W. HENDERSON, O. A. KERENSKY
Dept. of Civil Engineering,
Imperial College of Science and Technology,
London, S.W.17.,
June 17, 1960.

### THE CHANNEL CROSSING

SIR,—The idea about a dam between England and France, suggested, rather as an afterthought, in your leading article in THE ENGINEER of April 8 last, certainly is original. The disadvantages of a dam are numerous and evident. The construction of a dam would cut off the Gulf Stream from the south, and thus the temperature would certainly decrease and not increase. The dam would require enormous locks, which could easily be damaged in wartime, thus completely stopping all shipping through the Channel. Just think how attractive it would be to make the Suez Canal as wide as the Channel ; this plan for a dam would make another Suez Canal.

The North Sea does not contain much silt, but probably the resulting transport of sand would be directed southwards. This might necessitate a great deal of dredging work in order to keep the locks accessible. The great tidal range in the Channel would make the construction of a dam a very difficult job. However, a civil engineer can carry out any job, provided he can find somebody to supply the money.

I wish your country and France success with the construction of either a tunnel or a bridge ; the first contribution would be to drop the idea of a dam as soon as possible.

" ROOMPOT "
The Netherlands,
May, 1960.

### TRAFFIC PLANNING AND TRAMWAYS

SIR,—Your Continental Editor, in reviewing " Traffic Planning in Hamburg " (June 10, page 991) remarks " that tramways on the roads under modern conditions constitute a serious obstacle to traffic cannot be denied." The argument " that they should be entirely replaced by buses " might be thought to imply that buses constitute no such obstacle. The fallacy in this is shown by the reason for not accepting the argument, " that the additional 30 per cent of road space required cannot be afforded "—which suggests that buses to perform the same task as the trams would constitute an even more serious obstacle than do the trams ! We thus more reasonably (I submit) conclude that mixing appreciable public transport with private is a bad thing for both—for private transport in quantity is also a serious obstacle to public.

Segregation as a means of public transport is thus the one logical solution ; and in

Fig. 2, on page 992, is shown the simplest way of doing this—by providing a tramway reservation in the rebuilt roads. The kerb-to-kerb width of the supposedly three-lane carriageways is 30ft (yet so rarely does traffic on such roads flow freely in three streams : 12ft lanes seem expected nowadays, for free flow). With 3000 cars an hour in each of three lanes, and an estimated two passengers each, an extremely ideal flow of 18,000 passengers an hour would use the pair of carriageways.

The kerb-to-kerb width of the public transport reservation is about 21ft (scaling from the figure), along which the accurate and automatic guidance of the rails allows free flow of about eighty tram-trains per hour, with capacity for over 20,000 people each way, or 40,000 an hour on the two-way reservation. The 21ft public transport reservation can thus carry well over twice the maximum passenger flow likely to use the 60ft of carriageway, and hence, per unit of its width, is doing about six times the job.

It is interesting, too, to note that the kerb-to-kerb width of the public transport reservation is about 30 per cent of that of the two carriageways, so that if 30 per cent extra space can be afforded, its use for a reserved-track tramway served by modern cars (as the German " grossraumwagen ", which can hold 300 passengers) will enable the extra space to carry twice as much as the 100 per cent to which it was added. The value of such techniques to communities short of space and preferring not to waste resources cannot, equally, be denied.

B. JOHN PRIGMORE

New Malden,
Surrey,
June 13, 1960.

## Book Reviews

**Dock and Harbour Engineering. Vol. 2: *The Design of Harbours*.** By HENRY F. CORNICK, M.C., M.I.C.E. Charles Griffin and Co., Ltd., 42, Drury Lane, London, W.C.2. Price 126s.

THE second volume of Mr. Cornick's great work on the subject of docks and harbours is entitled *Design of Harbours* and makes detailed reference to a number of large harbour works that have been constructed in various parts of the world. Much of the information, indeed the best part of the information, contained in the volume has been extracted from the pages of previously published papers and periodicals and references are provided whereby the seeker after further information can trace the original sources. In addition to the main subject there are included in the volume sections dealing with a number of problems ancillary to " Harbour Design," such, for example, as the analysis of wave motions and actions, the ways and means for carrying out marine and submarine surveys, the study of shoal formations in the channels of rivers and tidal estuaries, and the methods that are employed for demarcating by means of buoys the navigable channels.

By virtue of its comprehensive character the work under review can to some extent serve the purpose of a general textbook and those young engineers intending to specialise in this branch of the civil engineering profession who succeed in reading this book through will no doubt make their mark later. Considered as a book of reference to which those already engaged in harbour design can turn for information on various aspects the book also possesses some value. It will, in addition, serve to preserve for posterity a record of the actual state of the harbour engineers art at the date of publication.

In dealing with the design of harbours there are two sides, two main aspects, that must be kept in view. First, the practical side which deals with physical forms, methods and materials of construction, and secondly the theoretical side which includes all sorts of scientific and mathematical analyses. Many years ago when Brysson Cunningham compiled his original work on docks and harbours it was possible to combine a description of the comparatively few and simple constructional forms that were then in use with an account of the elementary mathematical analyses that were then in vogue, but nowadays, owing to the immense volume of scientific research that has been carried out during recent years in developing new sciences such as soil mechanics and new techniques, such as the tidal model technique, it is no longer possible to deal adequately with the theoretical side in a work such as the present work, whose purpose is primarily practical and descriptive. It would therefore have been better if the author, recognising his inability to do justice to all these complicated mathematical matters, had abstained from introducing such analyses in the present volume.

Consider for example the treatment given to piles. It would have been interesting and instructive if the author had given a description with illustrations of all the principal forms of modern piles which enter so largely into and are of such fundamental importance in modern harbour works. Such a conspectus would have been more valuable than the fifteen pages of advice accompanied by empirical methods of calculation which are in fact provided.

Again, in the section where the author alludes to the use of floating structures in harbours, the description given of such structures in practical use is by no means as comprehensive as it might be, some of the space available having been devoted to the author's exposition of stability calculations. To anyone thoroughly conversant with hydrostatics such calculations can be more easily dealt with on first principles. To anyone untrained in hydrostatics the author's exposition of the subject is likely to prove inadequate if not dangerous.

Generally, right through the book the descriptions of practical forms of construction are somewhat limited and one-sided. In describing spring fenders, for example, there are included in the text descriptions and illustrations of costly appliances which may never be used again, while the very barest mention is made of certain more modern developments which seem likely to become standard practice in the future. In describing ancillary matters, such as buoying of navigable channels, the tendency of the text is to wrap the whole subject up in such a mass of verbiage as to make what should be fairly simple appear very difficult. It is possible to read the section on buoys without getting a clear understanding as to whether the conical topped port hand buoys are placed on the left-hand side of a ship entering or of a ship leaving the harbour.

There are several rather serious omissions. One of these is a failure to illustrate and do justice to the remarkable achievement of Dutch harbour engineers using sand and brushwood. Another omission is the failure to explain the principles of tidal model experiments and to emphasise how very important such methods have now become to every harbour designer. There is also a failure to emphasise the overwhelming importance which dredging technique occupies nowadays. The practicability of conducting various dredging operations is very often the deciding factor, and it is essential to have a good knowledge of what can and what cannot be done and maintained by means of dredging. The cost, too, is of paramount importance, but the tendency of the present work is to leave cost out of account.

Harbour engineering is a branch of the profession where more mistakes have been made by engineers in the past than in perhaps any other branch, and a comprehension of the past mistakes is the finest possible equipment which a harbour designer can possess. To be of real value a book such as this should be careful not to publish descriptions of past works of doubtful effectiveness unaccompanied by critical commentary, even if such criticism gives offence in certain quarters. Critical commentary of the kind calls, of course, for real insight and understanding of the practical problems, and this seems to be lacking.

However much this book must impress the reader as being a monument to the author's diligence and erudition, it fails to inspire and sometimes fails to convey a true sense of values.

**Progress in Non-Destructive Testing.** Vol. II. Edited by E. G. STANFORD and J. H. FEARON. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 55s.

THIS annual review appears to be a worthy successor to Vol. I, which has proved such a useful reference source for most of the topics covered. While there is a wealth of technical detail in some of the articles, the primary purpose of the editors is not the presentation of such data but rather of the physical background of established and newer techniques and of various laboratory research techniques which they regard as of high potential value in non-destructive testing and quality control. Volume II covers radiography with megavolt X-ray generators, dynamic mechanical testing of polymers, electrical resistivity methods, a wide range of research and control techniques using radioactive isotopes, ultrasonic flaw assessment as distinct from detection, anelastic damping studies of solid solution and precipitation effects, and finally paramagnetic resonance. The book should appeal to a wide range of readers, both academic and technical, who are interested in the physical basis of such techniques. There is, however, a wide variation in mode of presentation by the various authors, ranging from the gentle approach for the uninitiated to the more detailed mathematical approaches for the expert. Some rationalisation of editorial policy and directives to individual authors is desirable.

The first article on radiography using megavoltage X-ray generators, by the A.R.D.E. group, provides what has long been needed, an authoritative review of the relative merits of megavolt radiography (1 to 30 MeV) compared with radiography using isotope sources, and more particularly a comparison of the relative merits of various sources of megavolt radiation, such as the linear accelerators and the betatrons. The authors discuss fairly fully such aspects as the effect of voltage on absorption (penetration and contrast), radiographic unsharpness effects, beam angle (coverage) and flaw detection sensitivity. It is clear from this that an optimum voltage exists and little is to be gained by going to still higher voltages. British manufacturers have developed very

successful generators of the linear accelerator type, but appear to have been slow to exploit their application compared with their Continental and American rivals who have preferred the betatron type of equipment. This objective assessment should stimulate far wider interest in the accelerator equipment.

Dr. Kolsky, also of A.R.D.E., provides a useful introduction to the present state of the theoretical and experimental techniques for the study of the mechanical properties of high polymers or viscoelastic solids, particularly in relation to their marked dependence on strain rate, temperature and internal damping or friction effects. The inadequacy of the Voigt and Maxwell models is discussed, together with the promise of techniques based on the derivation of relaxation spectra by Fourier analysis. The author discusses four kinds of experimental approach and indicates the value of these techniques in applied work, and also includes an interesting but brief section on the significance of indentation and rebound hardness tests, which are so frequently used and abused in applied work. It is clear from this review that there is much useful research work to be carried out in this field. On the other hand progress is hindered by our inability to study directly the precise mechanisms of deformation as we do in similar work on metals and crystalline solids.

Dr. Vigness, of N.R.L. Washington, discusses briefly factors which influence the electrical resistance of metals and presents rather sketchily the effects of fatigue damage, phase transformations, ageing, ordering and orientation on electrical resistance. The author is more stimulating when he discusses resistance strain gauges and the effect of magnetostriction and plastic deformation on strain gauge factors. The final section discusses the influence of dislocations, vacancies and interstitials on electrical resistance. In view of the current interest in this field the treatment is disappointingly brief and incomplete.

The article on the use of isotopes in non-destructive testing and quality control covers the whole range of isotope techniques and takes us through nearly 200 references and all the elementary aspects of isotope characteristics and measuring techniques. The article contains a useful assembly of data of technical value on various types of thickness gauging techniques for use in a wide range of process control systems and makes brief mention of radiography, absorption analysis of hydrocarbon fuels, moisture analysis in soils, boron analyses in glasses, fluid pressure and flow measurements, viscometers and fire alarms. The author proceeds to discuss tracer techniques and rightly stresses that these are primarily research and study techniques for material transfer problems rather than methods for routine process control. Again a very comprehensive list of applications is given, ranging over wear studies, fluid flow, leak testing, ventilation, silting, and mixing efficiency in industrial processes. A brief section on activation analysis and fluorescence analysis is also included. Having presented a wealth of detail on the versatility of isotope techniques, the author wisely tempers his enthusiasm by terminating with a section on radiation hazards and precautions.

The article on ultrasonic assessment emphasises the difficulties of defect assessment now that the demand of engineers has advanced from defect detection and location to the specification of type, size, shape and orientation of defect. The author discusses the factors which govern echo response and the difficulties associated with test block comparators which are now in common use. It is clear that this approach is far from effective and it is all too easy seriously to underestimate the size of a flaw. Many readers will be stimulated and intrigued by the author's observations on the variation of echo response in the Fresnel (near) and Fraunhofer (far) zones, by the unexplained variations in response with depth of immersion of specimen and depth of defect in specimen, and would have welcomed more detailed discussion of these aspects and also of focusing probes which appear to offer some advantages in defect assessment.

The general article on anelastic damping effects in metals in Volume I is well followed in Volume II by a review of studies on solid solution and precipitation processes in metals using anelastic damping methods. The success that has been achieved in studies of interstitial solid solutions is quite remarkable, and one cannot but be impressed with the way the theory has been developed to permit the determination of solubility limits, diffusion coefficients, vacancy concentrations and even the shape of precipitate particles. The understanding of damping processes in substitutional solid solutions is less advanced, but even so the success achieved in the study of, for example, aluminium age-hardening alloys is impressive and encouraging.

The final article presents the theory and application of paramagnetic resonance techniques, particularly in relation to detection of impurities, analysis of free radicals and detection of damage centres such as *F* centres. The method, while still primarily of research interest, has in recent years been used in a number of problems of more applied interest, such as microchemical analysis of trace impurities in single crystals, studies of coal, and studies of radiation damage.

**Kolbenverdichter.** By CH. BOUCHE, revised edition. By KARL WINTTERLIN. Berlin-Göttingen-Heidelberg : Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.23.40.

THE handbook on piston compressors for students and designers has now been issued in a revised and up-to-date edition. In order to find room for the extensive additional matter which technical progress has made it necessary to include, a certain amount of design details are omitted, and in many cases the specialist is referred to the literature. The section on rotary piston compressors has also been omitted. The book covers the whole range of piston machines from vacuum pumps to high duty compressors for the chemical industry. Many sectional scale drawings illustrate the principal designs.

**Kinematisch-Getriebedynamisches Praktikum.** By RUDOLF BEYER. Berlin-Göttingen-Heidelberg : Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.29.40.

FACED with design problems involving increasingly high speeds and heavier masses, the engineer of to-day is forced more than ever to supplement his kinematic solutions with a detailed dynamic analysis. Professor Beyer's work, based on the author's lectures at Munich Technical University since 1950, is designed as a practical introduction to the statics and dynamics of two-dimensional linkages, with many practical illustrations for which detailed calculations and diagrams are given. After dealing with the basis of the subject in theoretical and technical mechanics, using elementary vector notation in order to simplify the treatment, the author discusses the consequences of d'Alembert's Principle in relation to the two fundamental problems of Wittenbauer, viz. to find the state of motion of the component parts of a transmission, given the external forces, internal resistances, and the distribution of masses ; or, alternatively, to find the external force which must be applied to a given configuration in order to achieve a certain required state of motion. In addition, the book deals with transmissions with double or multiple drive, movement of the centre of gravity, friction, and the fundamentals of balancing in co-planar systems.

## Books of Reference

*Deutsches Schiffahrt - und Hafen - Jahrbuch.* Fifty-seventh edition. Published by " Hansa " Zentralorgan für Schiffahrt, Schiffbau, Hafen, Hamburg : Schiffahrts-Verlag " Hansa " C. Schroedter and Co., Hamburg 11. Price DM.12.50. Like its predecessor, the *German Annual for Ports and Shipping*, 1960, forms a valuable book of reference for all whose interests are connected with matters of navigation. In the main section of the year-book will be found up-to-date information about German shipowners and ports. Addresses of head offices, names of directors, size of fleet, and other matters relating to the German shipping enterprises are listed, as well as installations, facilities, capacity and charges of the German maritime ports. Names of authorities, administrations, associations and firms connected with harbours and shipping are grouped according to laender. The section is headed by a survey of those federal ministries and specialist organisations which are connected with matters of the sea. *Inter alia* will be found the embassies and consulates of the German Federal Republic, as well as foreign missions in West Germany. A general section contains statistical information, common technical terms, tables of distances, conversion tables, &c. No less important may be the information about supplies and a list of foreign firms.

" *The Aeroplane* " *Directory of British Aviation*, 1960. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 30s.—The occurrence of many changes in the British aircraft industry and in Her Majesty's Government during 1959 render the new edition of this directory of more than usual reference value. Part III, " The Aviation Industry, British and Commonwealth," has been completely revised and reset, and has a loose supplement bringing the British entries up to date.

*Heat Bibliography*, 1958. National Engineering Laboratory. H.M. Stationery Office. Price 15s.—This bibliography contains material *noted* by N.E.L. during 1958, largely in abstracting and bibliographic journals.

Entries consist of titles, not abstracts. Four volumes covering the period 1948-57 were published previously, free of charge.

## Books Received

*Tin and its Alloys.* Edited by Ernest S. Hedges. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price £6 6s.

*The Arc Discharge, Its Application to Power Control.* By H. de B. Knight. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 63s.

*Concrete and Soil-Cement Roads.* By W. P. Andrews. Contractor's Record, Ltd., Lennox House, Norfolk Street, London, W.C.2. Price 30s.

*Zone Refining and Allied Techniques.* By N. L. Parr. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 40s.

*Technology and Culture.* Vol I, No. 1 (1960). Edited by Melvin Kranzberg. Wayne State University Press, Detroit 2, Michigan, U.S.A. Price 2 dollars.

*Méthodes Modernes D'Etude Des Systèmes Asservis.* By J. C. Gille, P. Decaulne and M. Pelegrin. Dunod, 92, Rue Bonaparte, Paris (6e). Price N.Fr.59.

*Foundation Design and Practice.* An Economic View. By J. H. Thornley. Oxford University Press, Amen House, Warwick Square, London, E.C.4, for Columbia University Press, Morningside Heights, New York. Price 120s.

THE ENGINEER

Technical Contributors Section

JUNE 1960

# Distribution of Shear Stress in a Box Beam

By B. A. WALKER, B.Sc. (Eng.), A.C.G.I., A.M.I.C.E.

*It is commonly assumed that in a symmetrical box beam, in which three webs are all of equal thickness, the bending shear force is equally divided between the webs, or if they are of unequal thicknesses that the shear force is divided proportionately, so that the average shear stress is equal in each web. In order to satisfy the principles of static equilibrium and minimum strain energy, it is shown in this article that the shear stress in the centre web is always greater than that in the side webs, when they are all of equal thickness, and that this difference is by no means negligible, being of the order of 20 to 30 per cent for most box beams found in practice, and can be as high as 50 per cent. Fig. 6 shows the ratio of the centre web stress to the side web stress for various values of k=web thickness/flange thickness and r=width/depth. The method given could equally well be applied to other cases of symmetrical box beams. The results are only applicable to cases in which the wall thicknesses are small compared with the other dimensions.*

## Method

THE beam is subject to bending by a vertical load, and plane sections are assumed to remain plane. Take the origin

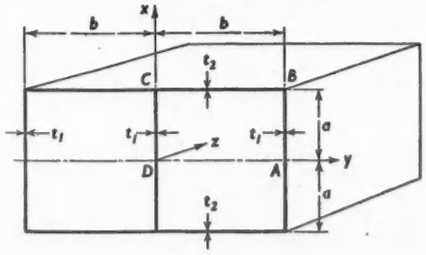



**Fig. 1.**

at $A$ and measure $s$ round the box. Considering the equilibrium of an element, we have the following equation :

$$\frac{\partial \sigma_{zz}}{\partial z}+\frac{\partial \tau_{sz}}{\partial s}=0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now

$$\sigma_{zz}=\frac{M}{I}\cdot x$$

where $M$ is the bending moment at the cross section and $I$ is the moment of inertia about the axis $y$–$y$.

Therefore,

$$\frac{\partial \sigma_{zz}}{\partial z}=\frac{\partial M}{\partial z}\cdot\frac{x}{I}$$

$$=\frac{S}{I}\cdot x \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $S$=shear force.

Inserting this value in (1), we have

$$S\cdot\frac{x}{I}+\frac{\partial \tau_{sz}}{\partial s}=0.$$

Therefore

$$\tau_{sz}=-\int\frac{S}{I}\cdot x ds+\tau_{sz}{}^{A} \quad . \quad . \quad (3)$$

where $\tau_{sz}{}^{A}$=shear stress at $A$.

Since $\tau_{zs}=\tau_{sz}$, the rigorous notation will be discontinued and the shear stress at a distance $s$ from the origin denoted simply by $\tau_s$.

From equation (3), and by considering equilibrium at the junctions, it is possible to find the shear stress at any part of the box in terms of the shear stress at the origin, or some arbitrary point. The value of the shear stress at the origin must be chosen so that total shear strain energy is a minimum. It is only necessary to consider the shear strain energy, since the bending strain energy is defined already by the known distribution of bending stresses.

The shear strain energy is

$$U=\int\frac{\tau_s^2}{2G}\cdot t_s\cdot ds \quad . \quad . \quad . \quad (4)$$

where $G$=shear modulus.

The shear strain energy may be expressed in terms of the shear stress at the origin, and for minimum energy we have the relation :

$$\frac{\partial U}{\partial \tau_A}=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence $\tau_A$ may be found and thus the shear stresses everywhere deduced.

## Application

Applying the method to the problem leads to the following results : consider first the length $A$ to $B$.

*AB.*—

$$\tau_s=-\frac{S}{I}\int x ds+\tau_A$$

$$=-\frac{S}{I}\cdot\frac{x^2}{2}+\tau_A.$$

Therefore

$$\tau_{BA}=-\frac{S}{I}\cdot\frac{a^2}{2}+\tau_A \quad . \quad . \quad . \quad . \quad (6)$$

$$\left[\frac{\partial U}{\partial \tau_A}\right]_{AB}=\int_0^a\frac{\tau_s}{G}\cdot t_1\cdot\frac{\partial \tau_s}{\partial \tau_A}\cdot ds$$

$$\frac{\partial \tau_s}{\partial \tau_A}=1.$$

Therefore

$$\left[\frac{\partial U}{\partial \tau_A}\right]_{AB}=\frac{t_1}{G}\int_0^a\left(-\frac{S}{I}\cdot\frac{x^2}{2}+\tau_A\right)ds$$

$$=\frac{t_1}{G}\left(-\frac{S}{I}\cdot\frac{a^3}{6}+\tau_A\cdot a\right) \quad . \quad (7)$$

*From B to C.*—Measuring $s$ from $B$, now, for equilibrium at the corner :

$$\tau_{BC}=\frac{t_1}{t_2}\cdot\tau_{BA}$$

$$=\frac{t_1}{t_2}\left(-\frac{S}{I}\cdot\frac{a^2}{2}+\tau_A\right) \quad . \quad . \quad . \quad . \quad (8)$$

$$\tau_s=-\frac{S}{I}\int ads+\tau_{BC}$$

$$=-\frac{S}{I}\cdot as+\frac{t_1}{t_2}\left(-\frac{S}{I}\cdot\frac{a^2}{2}+\tau_A\right) \quad . \quad (9)$$

$$\frac{\partial \tau_s}{\partial \tau_A}=\frac{t_1}{t_2}.$$

Therefore

$$\left[\frac{\partial U}{\partial \tau_A}\right]_{BC}=\frac{t_2}{G}\cdot\frac{t_1}{t_2}\int_0^b\left\{-\frac{S}{I}\cdot as+\frac{t_1}{t_2}\left(-\frac{Sa^2}{2I}+\tau_A\right)\right\}ds$$

$$=\frac{t_1}{G}\left\{-\frac{S}{I}\cdot\frac{ab^2}{2}+\frac{t_1}{t_2}\cdot b\left(\frac{Sa^2}{2I}+\tau_A\right)\right\} \quad . \; . \; . \; . \; . \; (10)$$

*From C to D.*—Measuring $s$ from $C$, from (9) :

$$\tau_{CB}=-\frac{S}{I}ab+\frac{t_1}{t_2}\left(\tau_A-\frac{Sa^2}{2I}\right) \quad . \; . \; . \; (11)$$

$$\tau_{CD}=\frac{2t_2}{t_1}\left\{-\frac{Sab}{I}+\frac{t_1}{t_2}\left(\tau_A-\frac{Sa^2}{2I}\right)\right\}$$

$$=-\frac{2t_1}{t_2}\cdot\frac{Sab}{I}+2\tau_A-\frac{Sa^2}{I} \quad . \; . \; (12)$$

$$\tau_s=-\frac{S}{I}\cdot\frac{s^2}{2}+\tau_{CD}.$$

Therefore

$$\tau_D=-\frac{S}{I}\cdot\frac{a^2}{2}-\frac{2t_2}{t_1}\cdot\frac{Sab}{I}+2\tau_A-\frac{Sa^2}{I}$$

$$=-\frac{3}{2}\cdot\frac{Sa^2}{I}-\frac{2t_2}{t_1}\cdot\frac{Sab}{I}+2\tau_A \quad . \; (13)$$

$$\frac{\partial\tau_s}{\partial\tau_A}=2.$$

Therefore

$$\left[\frac{\partial U}{\partial \tau_A}\right]_{CD}=\frac{2t_1}{G}\int_0^a\left\{-\frac{S}{I}\cdot\frac{s^2}{2}-\frac{2t_2}{t_1}\cdot\frac{Sab}{I}+2\tau_A-\frac{Sa^2}{I}\right\}ds$$

$$=\frac{2t_1}{G}\left\{\frac{S}{I}\left(-\frac{a^3}{6}-\frac{2t_2}{t_1}\cdot a^2b-a^3\right)+2\tau_A\cdot a\right\} \quad . \; . \; . \; . \; . \; (14)$$

Multiply equations (7) and (10) by 4, equation (14) by 2, add and equate to zero.

Hence,

$$\frac{4t_1}{G}\left(-\frac{Sa^3}{6I}+\tau_A\cdot a\right)$$

$$+\frac{4t_1}{G}\left\{-\frac{S}{I}\cdot\frac{ab^2}{2}+\frac{t_1}{t_2}b\left(-\frac{Sa^2}{2I}+\tau_A\right)\right\}$$

$$+\frac{4t_1}{G}\left\{\frac{S}{I}\left(-\frac{a^3}{6}-\frac{2t_2}{t_1}\cdot a^2b-a^3\right)+2\tau_A\cdot a\right\}=0$$

Simplifying, we obtain :

$$\tau_A=\frac{S}{I}\cdot\frac{ab^2+a^2b\left(\frac{t_1}{t_2}+\frac{4t_2}{t_1}\right)+\frac{8}{3}a^3}{6a+\frac{2t_1}{t_2}\cdot b} \quad . \; (15)$$

and from (13) :

$$\tau_D=-\frac{S}{I}\left(\frac{3}{2}a^2+\frac{2t_2}{t_1}\cdot ab\right)+2\tau_A \quad . \; . \; (16)$$

For thin-walled sections, assumed under consideration, the moment of inertia is given approximately by :

$$I=3t_1\frac{(2a)^3}{12}+4t_2ba^2=2t_1a^3+4t_2a^2b.$$

Writing

$$\frac{t_1}{t_2}=k \text{ and } \frac{b}{a}=r,$$

we obtain

$$\tau_A=\frac{S}{2t_1\cdot a}\cdot K_A \quad . \; . \; . \; (17)$$

where

$$K_A=\frac{r^2+kr+\frac{4r}{k}+\frac{8}{3}}{\left(1+\frac{2r}{k}\right)(6+2kr)}$$

and

$$\tau_D=\frac{S}{t_1\cdot a}\cdot K_D \quad . \; . \; . \; . \; (18)$$

where

$$K_D=-\frac{3+\frac{4r}{k}}{4+\frac{8r}{k}}+K_A.$$

Values of $K_A$ and $K_D$ are given in the accompanying graphs, Figs. 3 and 4.

*Example.*—

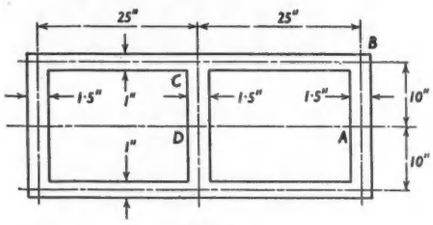



**Fig. 2.**

From equation (15), inserting the following numerical values :

$a=10$in, $b=25$in

$I=12{,}878\text{in}^4$,

and if

$S=10{,}000$ lb,

$$\tau_A=\frac{10{,}000\times 19{,}317}{12{,}878\times 135}$$

$=111$ lb per square inch,

and $\tau_D$ from equation (16) is

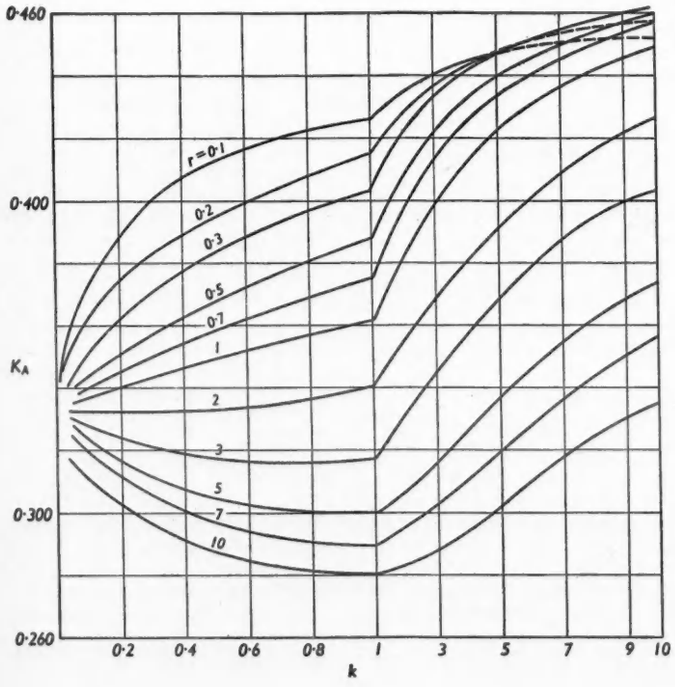
$=-153$ lb per square inch.

$\tau_{BA}=+72$ lb per square inch.

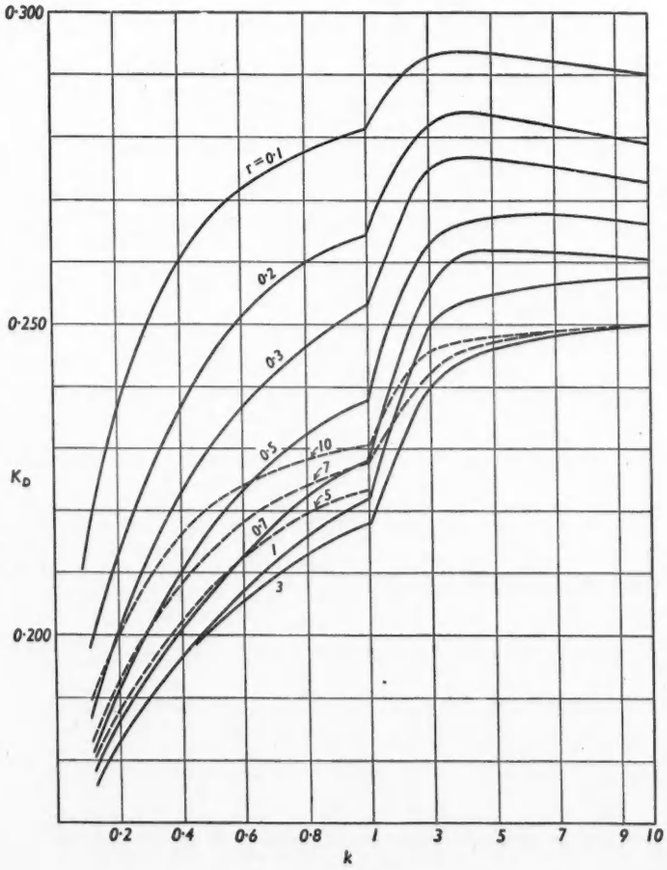
$$\tau_{BC}=\frac{1\cdot 5}{1}\times 72=108 \text{ lb per square inch.}$$

$\tau_{CB}=-86$ lb per square inch.

$\tau_{CD}=114$ lb per square inch.




(Above) **Fig. 3—Values of $K_A$**




(Right) **Fig. 4—Values of $K_D$**

The distribution is shown plotted in Fig. 5.

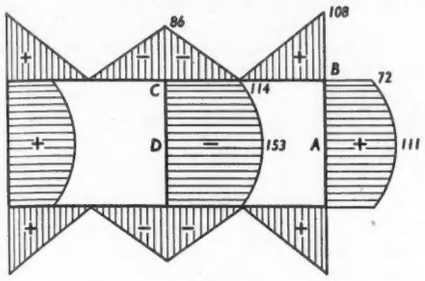



Fig. 5

The distribution could have been calculated more easily by reference to the curves.

$$k=\frac{t_1}{t_2}=\frac{1\cdot5}{1}=1\cdot5$$

$$r=\frac{25}{10}=2\cdot5.$$

Therefore

$K_A=0\cdot334$ and $K_D=0\cdot228$.

Therefore

$$\tau_A=\frac{10{,}000}{2\times1\cdot5\times10}\times0\cdot335=111\text{ lb per square inch.}$$

$$\tau_D=\frac{10{,}000}{1\cdot5\times10}\times0\cdot228=152\text{ lb per square inch.}$$

| $k$ \ $r$ | 0·1 | 0·2 | 0·3 | 0·5 | 0·7 | 1 | 3 | 5 | 7 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0·1 | 1·145 | 1·10 | 1·064 | 1·057 | 1·048 | 1·047 | 1·072 | 1·112 | 1·146 | 1·203 |
| 0·3 | 1·250 | 1·179 | 1·150 | 1·125 | 1·116 | 1·117 | 1·190 | 1·261 | 1·310 | 1·418 |
| 0·5 | 1·286 | 1·236 | 1·206 | 1·179 | 1·162 | 1·162 | 1·265 | 1·368 | 1·440 | 1·539 |
| 0·7 | 1·310 | 1·255 | 1·223 | 1·212 | 1·173 | 1·187 | 1·320 | 1·449 | 1·509 | 1·611 |
| 1·0 | 1·319 | 1·281 | 1·256 | 1·230 | 1·226 | 1·231 | 1·372 | 1·495 | 1·578 | 1·630 |
| 3 | 1·322 | 1·290 | 1·271 | 1·250 | 1·236 | 1·250 | 1·400 | 1·526 | 1·602 | 1·696 |
| 5 | 1·311 | 1·263 | 1·233 | 1·212 | 1·210 | 1·207 | 1·340 | 1·450 | 1·532 | 1·631 |
| 7 | 1·295 | 1·228 | 1·216 | 1·185 | 1·170 | 1·170 | 1·278 | 1·393 | 1·481 | 1·560 |
| 10 | 1·281 | 1·212 | 1·205 | 1·156 | 1·140 | 1·140 | 1·232 | 1·325 | 1·394 | 1·481 |

Fig. 6—Values of ratio $\tau_D/\tau_A$

# Self-Induced Ventilation of Road Tunnels

By C. GURNEY, M.A., D.Sc., F.Inst.P., F.R.Ae.S.,* and L. H. BUTLER, M.Sc.(Eng.), M.Sc.(Wales), A.M.I.Mech.E., A.F.R.Ae.S.†

*Model and full-scale systems have been used to measure the draughts induced by the movement of traffic in otherwise unventilated, single direction road tunnels. An approximate theory has been developed which gives satisfactory agreement with experimental results, and it has been used to predict the carbon monoxide contamination likely to be experienced under various conditions of traffic flow. The results show that for tunnels up to moderate lengths (3000ft to 4000ft) the level of carbon monoxide contamination is likely to remain within the safety limit of 4 parts per 10,000 except under the most arduous conditions of traffic operation, and that tunnels up to 1000ft in length can safely be regarded as self-ventilating for all practical purposes. It was found in full-scale tests at London Airport, however, that adverse winds could more than halve the vehicle-induced draught, showing that the orientation of the tunnel and local topography must be taken into account.*

TO control humidity, smoke, smell and particularly toxic gas contamination in long road tunnels, it is common practice to install forced ventilating plant, which is expensive in capital, maintenance and operating costs. It is generally considered that, for safety, the concentration of carbon monoxide (which is the most dangerous toxic constituent likely to be encountered) should be maintained at a level of less than 4 parts in 10,000 by volume. Since all internal combustion engine vehicles discharge CO, the ventilation requirements are largely dependent on the current traffic type and density, and a ventilating plant may be operating uneconomically during periods of fluctuating traffic flow. In a tunnel carrying traffic in one direction only, however, it is likely that the vehicular drag will induce a draught in the direction of the traffic motion, this draught being related to the traffic type and density. If such an induced draught is of sufficient magnitude, it may obviate the need for separate ventilating plant under favourable conditions.

To investigate whether traffic induced ventilation is practicable, particularly at the length (1120ft) of the proposed Crindau (Newport by-pass) tunnel, work has been carried out on behalf of the Ministry of Transport and Civil Aviation in an attempt to predict likely induced draughts in tunnels of various dimensions with various traffic conditions. A preliminary theoretical investigation on the Crindau tunnel (based on a method proposed by National Physical Laboratory) was carried out by Sir Owen Williams and Partners.[1] This showed that adequate self-ventilation might be expected under all practical traffic conditions. Some uncertainty attended the calculations, however, and it was thought desirable that experiments should be carried out to check their validity. The National Engineering Laboratory (formerly M.E.R.L.), East Kilbride, accepted the responsibility for this work and asked the Engineering Department of University College, Cardiff, to carry out the investigation. It was decided to conduct a series of experiments on a laboratory water tunnel analogue, full-scale trials in the London Airport tunnels and experiments on a laboratory model road tunnel.

* Professor of Civil and Mechanical Engineering, University of Wales, University College, Cardiff.
† Lecturer in Engineering, University of Wales, University College, Cardiff.

## Laboratory Water Model Tests

*Equipment.*—Model "vehicles" attached to a continuous piece of string, were drawn through a 3in diameter pipe with the apparatus shown in Fig. 1. Most of the tests were made with a pipe 9ft long, in which two 15in long "Perspex" windows were installed, at the quarter and half-way marks. Pitot and static tubes were also fitted to this pipe, at points 9in from each end. Later, a few tests were made with a 15ft long pipe.

Bicycle wheels, retaining their normal bearings and axles, were mounted on steel frames spanning their respective tanks and slid in guides lubricated with graphite and grease. Idler pulleys, 9in in diameter for the large model vehicles and 11in for all other tests, were mounted on the same frames as the wheels; they had brass bushes and ran on steel pins with water lubrication. The whole frame could be moved vertically, to vary the position of the models in the pipe. Power was provided by a variable speed a.c. motor, through a chain and sprocket drive to one of the bicycle wheels. The motor, with 4 h.p. output at maximum speed, had a speed range of 0–1650 r.p.m.

The water which the passage of the models "pumped" into the driving-end tank passed down a channel into a measuring tank, whence, after passing over a 90 deg. vee notch, it was pumped into the driven-end tank by a "plurovane" pump. The pump was driven by a variable speed d.c. motor and was fitted with a manual control which operated a throttle valve in the delivery pipe. The water levels in the two tanks were normally maintained at the same datum height, but a difference in levels could be imposed by means of this throttle valve so that there was a pressure differential across the ends of the pipe. This was used in some tests to simulate the effect of a natural wind blowing on one end of a tunnel.

The wooden models were drawn through the pipe on a continuous string threaded through their centres, and were either ¾in or 1½in maximum diameter. The surface profiles were either cylindrical or streamlined, the equation of the latter being:

$$y=\pm5t(0\cdot2969x^{\frac{1}{2}}-0\cdot1260x-0\cdot3156x^2+0\cdot2843x^3-0\cdot1015x^4),$$

where $y$ is the thickness, $t$ (=0·5) is the thickness chord ratio, and $x$ is the fraction of the chord, measured from the leading edge. This equation is derived from a well-known N.A.C.A. series of symmetrical aerofoil profiles.

The speed of the models was derived from the speed of the driven-end wheel, which was measured by a counter and stop-watch. The range of model speed was from 0ft to 15ft per second. The volume of water pumped was found from readings of a hook-gauge, which measured the height of the water above

*Notation*

$u$—Model (vehicle) speed.
$v$—Mean speed of tunnel fluid medium (water, air).
$n$—Number of models (vehicles) in tunnel.
$s$—Model (vehicle) spacing.
$k$—Tunnel end loss factor.
$A_t$—Tunnel cross sectional area.
$C_t$—Tunnel wall drag coefficient.
$P_t$—Tunnel perimeter.
$l$—Tunnel length.
$A_v$—Vehicle (model) frontal area.
$C_v$—Vehicle (model) drag coefficient.
$Q$—Volume flow of tunnel fluid medium.
$C_1$, $k_1$, $k_2$, $k_3$, $k'$—Constants in equations.

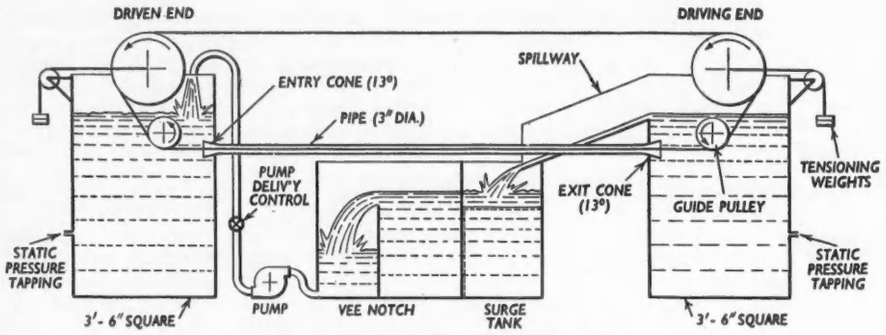



Fig. 1—Apparatus for water model tests

the bottom of the vee notch. The temperature of the water was measured with a mercury-in-glass thermometer marked in 0·2 deg. Cent. intervals.

*Experiments.*—The main variables considered likely to influence the induced flow were : speed, spacing, shape and length of models ; length, diameter, surface roughness and entry and exit conditions of the pipe ; pressure difference between the ends of the pipe. Eleven of the twelve series of tests were made with the 9ft long pipe and all models had a length : diameter ratio of 2.

The programme was necessarily designed round an idealised system and hence factors such as unequal spacing and speeds of successive models were not considered. The series of tests carried out were concerned with determining in this " ideal " system the effect of the variables listed above and spacings of 6in, 9in, 12in and 18in were

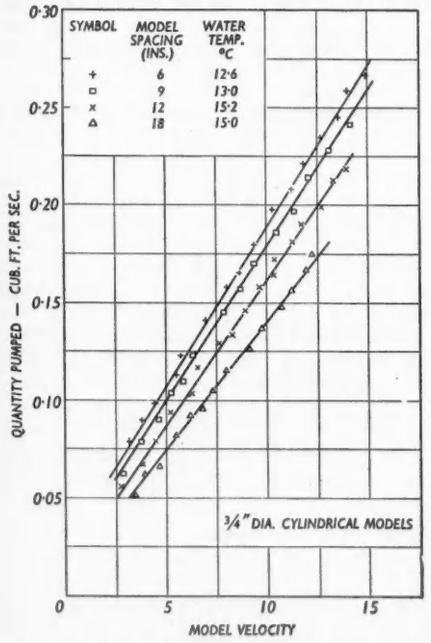



Fig. 2—Variation of quantity of water pumped with model spacing

used. For zero differential head and other conditions constant the quantity pumped by movement of the models through the water varied linearly with the model speed (Fig. 2). Typical relationships are given in Table I, where $Q$ is in cusecs and $u$ is the model speed in feet per second ; the degrees of freedom are based on the number of test points used and the high correlation coefficients show the goodness of the fitted curves.

Some of the data obtained with a differential static head are shown in Fig. 3. Attempts to measure local water velocities with pitot tubes gave very variable results, but indicated

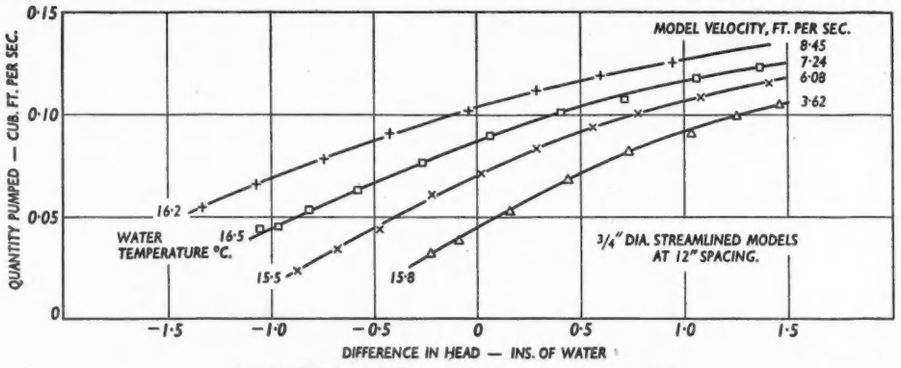



Fig. 3—Effect of differential head on quantity pumped

a velocity profile approximately constant over the range ±1½in from the pipe centre line. Fig. 4 shows the variation of the ratio of average water speed to model speed plotted against the number of models in the pipe. The Reynolds numbers quoted are based on model diameter. The points marked $n=36$ and $n=72$ were obtained from experiments in which tubing was pulled through the pipe to represent a continuous array of cylindrical models. The results suggest that there exists a spacing at which pumping is maximum and that for closer spacing the quantity pumped decreases. Except for the 1½in diameter models, the optimum spacing was outside the range of the experiments. To explore any influence of string size on quantity pumped, the ¾in and 1½in cylindrical models were run with various thickness of string but no great difference in quantity pumped was observed. String alone and tubing alone were found, however, to pump quite large quantities. Variation of entry and exit conditions affected flow ; with the conical entry and exit fittings removed, there was a reduction in flow of about 12 per cent. Locking the idler pulleys produced little effect. The substitution of the 15ft pipe caused a reduction in flow which was small at the higher speeds but of the order of 20 per cent at the lower speeds. When the models were illuminated through the " Perspex " windows with a stroboflash, motion was seen to be steady and with no obvious cavitation up to model speeds of 14ft per second. Above this speed, cavitation occurred.

*Discussion of Results.*—At zero differential head the linear variation between quantity pumped and model speed is a consequence of all forces and momentum rates of change being proportional to the same power (usually taken as 2) of the appropriate velocities. Head loss at entry and exit is usually taken as $k_1v^2$, and retarding frictional forces from the walls as $k_2v^2$. The forward action of the models and string on the water may be represented by $k_3\ (u-v)^2$ and the value of $k_3$ increases with increase in bluffness. Under steady running conditions equating the impelling and retarding forces leads to a linear relationship between $v$ and $u$. When a differential head is present the unbalanced force it produces is independent of $v$ and the linear relationship would no longer be expected. The maximum in the flow as the number of models in the pipe was increased is due to an interference effect of closely spaced models.

The presence of the string renders the interpretation of the results more difficult, but it would be wrong to suggest that the quantity pumped by models alone could be obtained by subtracting the quantity pumped by string alone from the quantity pumped

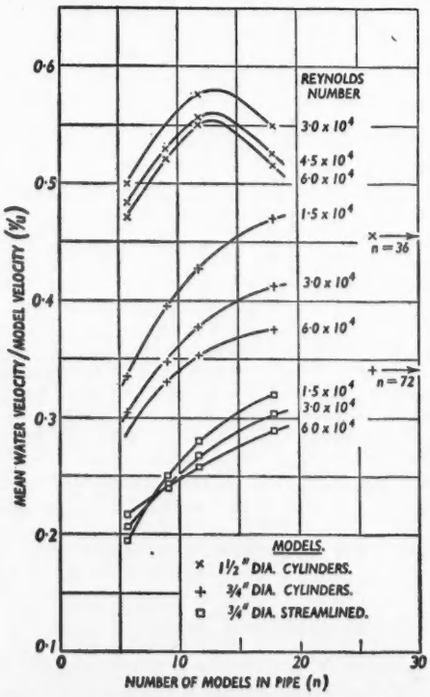



Fig. 4—Variation of $v/u$ with number of models in pipe at constant Reynolds number

TABLE I—*Relationship Between Quantity Pumped and Model Speed*

| Series | Model | | | Curve | Degrees of freedom | Correlation coefficient |
|---|---|---|---|---|---|---|
| | Diameter | Shape | Spacing, inches | | | |
| 1 | ¾ | Cyl. | 9 | $Q=0{\cdot}015+0{\cdot}016u$ | 41 | 0·998 |
| 1 | ¾ | Str. | 12 | $Q=0{\cdot}002+0{\cdot}0116u$ | 31 | 0·999 |
| 6 | 1½ | Cyl. | 6 | $Q=0{\cdot}013+0{\cdot}0235u$ | 12 | 0·997 |
| 12 | 1½ | Cyl. | 12 | $Q=0{\cdot}010+0{\cdot}0153u$ | 15 | 0·998 |

by models and the string. It is reasonable to suppose that the models mask the string for most of the distance between the models and the results for model and string together are probably not appreciably different from that of models alone. The variation of quantity pumped with entry and exit conditions and with differential head suggest that natural flow will be increased by flared entry and exit of full-scale tunnels and that external wind effects will be important. The results, described more fully in reference 2, suggested that increase in tunnel length exceeding a certain fairly short measurement may not have an important effect on flow.

The quantity pumped was considered to be sufficiently large to suggest that full-scale tunnels of medium length would be self-ventilating and to justify further work more nearly approaching practical conditions.

## Air Flow Measurements in London Airport Tunnels

To gain full-scale experience and to assess any scale effect in the air model experiments reported later, measurements of induced air flow were made in the London Airport tunnels. Each main traffic tunnel is rectangular in cross-section, about 26ft 6in wide by 17ft high. The twin road tunnels are flanked by pedestrian and cyclist tunnels about 13ft 6in wide, with the ceiling height at the level of the main tunnels. The floor level of the side tunnels is raised above that of the main tunnels by about 7ft 6in and the space beneath is used as a ventilation duct for the main tunnels. The tunnels are 2060ft long. Entrance and exits are in a cutting, road level being about 30ft below surrounding ground level. The tunnel ends are completed by vertical transverse retaining walls. Road level at the airport end of the tunnels is about 10ft 6in above that of the entrance. A catwalk and hand rail are situated in the main tunnels on each side of the central partition wall. A general view of the tunnel entrance is shown in Fig. 5. The direction of the tunnel is due north–south.

*Methods of Measuring Air Flow.*—The object of ventilation is to reduce the concentration of noxious gases, and the best measure of vehicle-induced ventilation would be the mass air flow in the tunnel. Various methods, including gaseous, powder and radioactive tracer methods were considered but none was practicable for the flow conditions in the tunnel.

Air speeds were, therefore, measured at twelve points in the tunnel, using hot-wire anemometers. Wires of 25 S.W.G. were mounted in tubes of 3in diameter and 30in length. These had to be arranged to be clear of traffic and they were supported on scaffolding above the catwalk at positions shown in Fig. 6 and at a section 389ft from

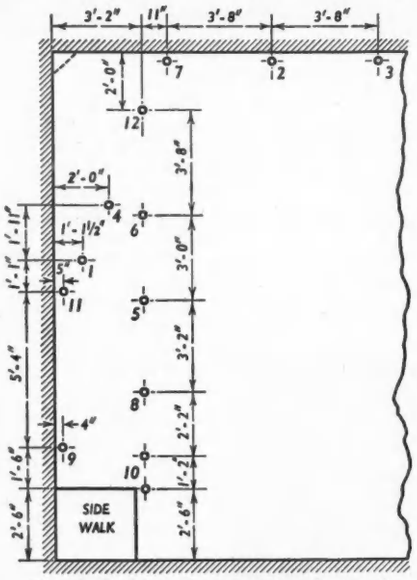
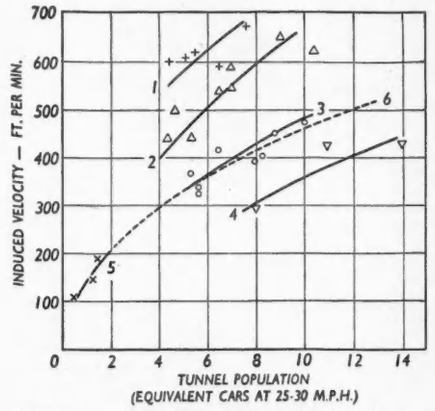



Fig. 6—Position of anemometers in tunnel

the entrance of the entry tunnel to the airport. (The view shown in Fig. 6 is looking upstream towards the entrance of the tunnel.) The hot wires were connected in series to the same battery and their temperatures were measured by thermocouples welded to the wires. The thermocouple millivoltmeters were mounted side by side in a box together with the battery, ammeter and a clock. They were photographed at suitable intervals of time. The anemometers were calibrated, before and after use, in a wind tunnel using a deflecting-reed-type instrument (a Metropolitan-Vickers "Velometer") as a secondary standard. Only small changes in calibration were detected. Measurements of air velocity were also made by injecting bursts of nitrous oxide, $N_2O$ into the tunnel and by timing their passage between the injection point and an infra-red gas analyser placed a known distance downstream in the tunnel.

A census of traffic and measurement of its speed was made by manually operated switches which interrupted the traces of pens on a multiple-pen recorder. Information regarding atmospheric wind speeds was obtained from the airport records. A total of fifteen sets of readings was obtained, some with the artificial ventilation off. Seven sets have been analysed, giving a representative cross-section of the conditions.

*Experimental Results.*—The anemometers indicated violent fluctuations of velocity during the passage of vehicles in their vicinity, and steady trends of velocity gradients when the vehicles were remote from the instrument. The mean readings of Nos. 5, 6 and 8 (above the rail of the catwalk, see Fig. 6) the mean of Nos. 2, 3 and 7 (near the ceiling) and also the reading of No. 9 (at junction of wall and floor) were plotted against time ; and the passage of vehicles past the recording point was plotted on the same graph. Nos. 2, 3 and 7 gave mean readings which averaged about 70 per cent of those at Nos. 5, 6 and 8. Reading No. 9 averaged about 60 per cent of that of Nos. 5, 6 and 8. In the absence of more precise data it is reasonable to take the mean of 5, 6 and 8 as the best estimate of the mean air velocity down the tunnel. By choosing times at which traffic density was fairly steady, it has been possible to construct rough curves of mean velocity plotted against the number of cars in the tunnel and travelling at 25–30 m.p.h. (Fig. 7). Buses were evaluated as




(1) Component wind velocity 430ft per minute—north.
(2) Component wind velocity 450ft per minute—north.
(3) Component wind velocity 150ft per minute—north.
(4) Component wind velocity 430ft per minute—south.
(5) Component wind velocity 35ft per minute—south.
(6) Predicted from model experiments—no wind.

**Fig. 7—Relationship between induced air velocity and traffic at London Airport**

Fig. 5—London Airport tunnels

equivalent to six cars and appropriate evaluation was made for commercial vehicles. The curve marked 5 in Fig. 7 corresponds to low density traffic and was derived from the night tests. It has been obtained by correcting the experimental air speed for speed of traffic, on the assumption that air speed varies linearly with traffic speed. This assumption is supported by the water model and the air model tests. The infra-red gas analyser (I.R.G.A.) readings which were taken near the floor of the catwalk agreed fairly well with the readings of instruments Nos. 2, 3 and 7. By selecting readings of air speed when traffic was absent from the tunnel it has been possible to construct an air speed decay curve (Fig. 8). The points marked *cc* and *dd* were obtained from a night test in which the atmospheric wind speed was negligible, but the points

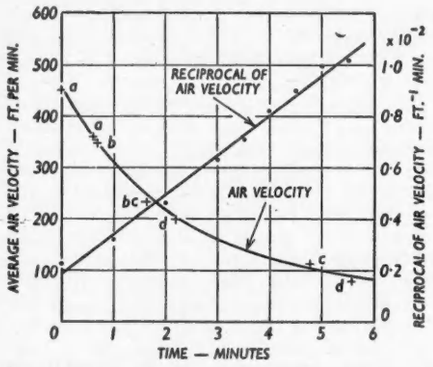

AVERAGE AIR VELOCITY — FT. PER MIN.
RECIPROCAL OF AIR VELOCITY — FT.⁻¹ MIN.
x 10⁻²
RECIPROCAL OF AIR VELOCITY
AIR VELOCITY
TIME — MINUTES

**Fig. 8—Decay of air velocity after passage of vehicles (*a*-*a*, *b*-*b*, &c., are different film records showing this effect)**

marked *aa*, *bb* correspond to an adverse wind having a component in the direction of the tunnel of about 430ft per minute. Decay under still air conditions would, therefore, be slower.

meteorological records taken at half-hourly intervals. It may be that the figures quoted for wind speeds on Fig. 7 differ appreciably from the mean speeds during the tests.

Curve 6 of Fig. 7 is the predicted tunnel air speed for zero atmospheric wind, calculated from equation (3) of the later section concerned with the laboratory air model, and using a vehicle drag coefficient of 0·798 and a tunnel wall drag coefficient of 0·0134. These values gave agreement with the model experiments. The equation to curve 6 is :

$$v=\left(\frac{u}{1+13n^{-\frac{1}{2}}}-20\right) \quad . \quad . \quad . \quad . \quad (1)$$

where $v$ and $u$ are tunnel air speed and traffic speed respectively, both in feet per minute, and $n$ is the number of "equivalent" cars in the tunnel. It will be noted that curve 6 lies between the experimental curves for a wind with favourable component of 150ft per minute and that for a wind with unfavourable component of 430ft per minute; and that it lies closer to the former. The lower part of curve 6 agrees very well with curve 5, which was obtained during a night test with low traffic density and almost still outside air.

re-circulation of air was taking place, air from the outgoing tunnel returning to enter the entry tunnel.

### Laboratory Air Model Tests

Laboratory air model tests were undertaken to investigate the variation of the induced air velocity in road tunnels under controlled conditions, and to establish the scale factor relating model and full-scale systems.

*Equipment Used and Measurement of Air Flow.*—Two tunnel replicas were used, one of the Crindau and one of the London Airport tunnel (Fig. 9). They were made to $^{1}/_{48}$th of full-scale, chosen to suit the model vehicles used (Riley saloon cars and Bedford trucks). The maximum lengths were 46ft but they could be split for testing at shorter lengths. Details of the model assembly are shown in Fig. 10. The tunnel was made of plywood and the vehicles were mounted on a belt running in a thin horizontal slot below the floor. The slot was lined with P.T.F.E. tape to reduce friction,

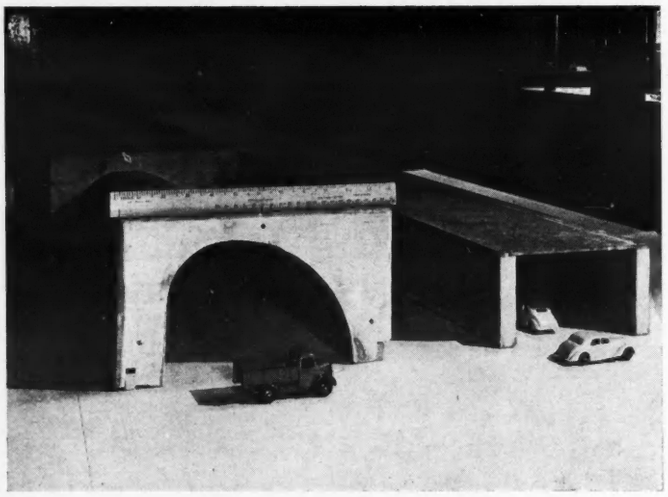
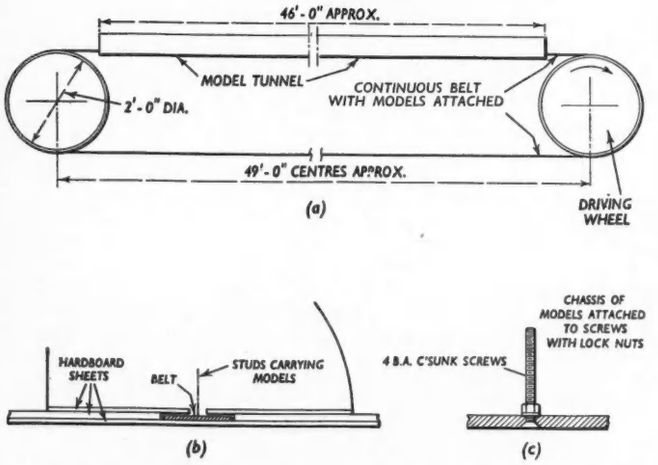


**Fig. 9—Model tunnel sections and vehicles**




(*a*) General arrangement of tunnel, belt and driving system. (*b*) Shielding of major part of belt. (*c*) Attachment of models to belt.

**Fig. 10—Apparatus for air model tests**

*Discussion of Results.*—Analysis of the results was tedious, involving many thousands of readings of the pointer positions on the film records. The random nature of the traffic, and the persistence of flow caused by previous vehicles, and by external atmospheric wind makes interpretation difficult. The curves in Fig 7, which give mean readings of anemometers 5, 6 and 8, were obtained from sets of readings when traffic was fairly steady. No great accuracy should be ascribed to them, but they do indicate a general trend of results. The presence of artificial ventilation made no noticeable difference to the readings. In contrast, outside atmospheric wind has a very marked effect.

With eight cars (or their equivalent) passing through the tunnel at a time, a change from a wind with a velocity component in the direction of the traffic of 450ft per minute, to a wind of equal magnitude blowing against the traffic, caused a change of air speed in the tunnel from about 600ft to about 300ft per minute. On one occasion it was noticed that the flow in the outgoing tunnel during a period of low traffic was actually reversed by the action of the wind.

There is an apparent discrepancy between curves 1 and 2 of Fig. 7, which correspond to about the same component of wind velocity in the direction of the tunnel. The wind speeds were obtained from the airport

When vehicles are absent, the combined wall drag, and force due to pressure difference at the two ends of the tunnel, must equal the mass of air in the tunnel multiplied by its deceleration. If wall drag and end force vary as $v^2$ the air speeds under natural decay conditions should be given by :

$$\frac{1}{v_2}-\frac{1}{v_1}=k'(t_2-t_1)$$

where $k'$ is constant.

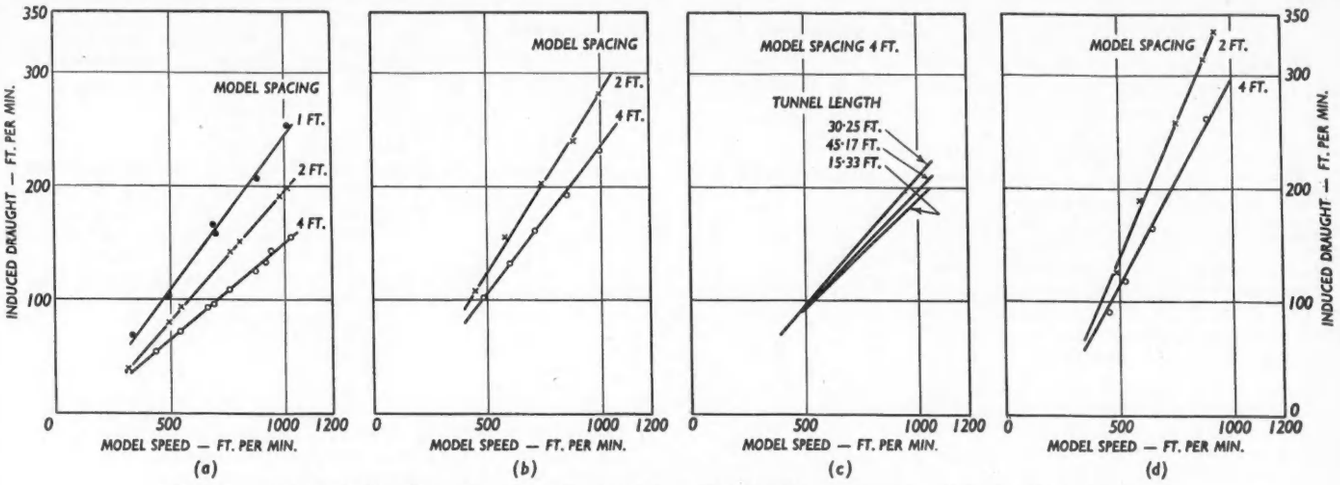
This formula is reasonably consistent with Fig. 8 and the experimental value of $k'$ is $1{\cdot}54\times10^{-3}$ when $v$ is measured in feet per minute. With this value of resistance and with the vehicle drag previously quoted, the predicted relationship between $v$ and $u$ under windless conditions becomes :

$$v=\left(\frac{u}{1+13{\cdot}3n^{-\frac{1}{2}}}-20\right) \quad . \quad . \quad . \quad (2)$$

The small difference between the constant 13 in equation (1) and 13·3 in equation (2) is fortuitous since the decay of air velocity shown in Fig. 8 was not deduced solely from readings during windless periods. By blowing soap bubbles near the tunnel mouth, it was found that considerable and the upper surface of the belt was shrouded as much as possible to reduce the draught induced by its movement. The vehicles, attached to the belt at spacings of 1ft and upwards in multiples of 1ft as required, were carried through the tunnels at speeds normally up to 1100ft per minute. A final series of tests were run, however, up to a speed of 2800ft per minute.

Two methods of measuring air flow were used. In the first, carbon dioxide was metered at a known rate into the tunnel near the entry and analysed with a Haldane apparatus near the exit. The percentage contamination at exit enabled the mean induced velocity to be calculated. Although this was considered to be the most reliable method, it was cumbersome for the numerous tests envisaged, and so supplementary mean air velocity readings were taken by timing the passage of smoke (titanium tetrachloride exposed to the atmosphere) through the tunnel. It was found that good correlation could be achieved with the two methods, and the smoke timing technique was generally used.

*Test Programme.*—The programme of tests was designed so that the Crindau model was used for the majority of the work and the general investigation, whilst the London air model was used primarily to check the scale effect by comparison with the full-scale results reported in a previous section.




(*a*) Crindau tunnel—length 46ft—Riley models. (*b*) Crindau tunnel—length 16·75ft—Bedford truck models. (*c*) London Airport. Riley models. (*d*) London Airport, tunnel length 45·2ft—Bedford truck models.

**Fig. 11—Typical results of tests on Crindau and London Airport models**

In the programme on the Crindau model each of the main factors considered likely to influence the induced air velocity (as discussed earlier for the water model tests) was varied in turn. A similar, but restricted, series of tests was conducted on the London airport model. An additional factor—variation of tunnel wall drag—was considered separately.

*Discussion of Results.*—Fig. 11 shows graphically the typical results of a few of the tests on the Crindau and London airport model tunnels, whilst Fig. 12 shows the form obtained by cross plotting. The complete sets of results are contained in reference 3. Fig. 13 shows the results obtained from tests with different tunnel wall drag. The tests confirmed the results of the water tunnel analogue in that a linear relationship exists between model speed and induced velocity, other factors being fixed. Closer model spacing increases the draught, as does also increased model drag, whilst increasing tunnel length is associated with increasing draught up to moderate lengths after which the draught remains sensibly constant.

An anomaly is apparent in some of the plots of induced draught against tunnel length, where the draught rises to a maximum at a particular tunnel length, thereafter falling slightly. Although tunnels of sufficient length were not available to establish whether or not this trend would stop, it is reasonable to assume[4] that the draught will ultimately settle at a constant value with no excessive reduction from the maximum.

Fig. 13, illustrating the effect of varying tunnel wall roughness, shows that no reduction in draught could be detected experimentally even with considerable variation in wall roughness. The relative roughness ratio of the two surfaces used was 25 : 1 (see Fig. 14) and from theoretical considerations[4] a reduction of draught of up to 20 per cent might have been expected. However, the theoretical approach was based on work done under highly idealised conditions which are almost certainly not applicable to the practical conditions currently encountered.

*Analysis of Results.*—A theoretical approach to the problem was made[3] on the basis that, in still external atmospheric conditions with steady traffic flow in the tunnel, the forward drag of the vehicles on the air in the tunnel is balanced by the wall frictional drag plus the retarding forces due to entry and exit losses. Assuming forces proportional to squares of relative velocities, this led to the relationship :

$$v=\left[\frac{u}{1+\sqrt{s}\sqrt{\frac{kA_t+C_tP_tl}{C_vA_vl}}}-C_1\right] \quad . \quad . \quad (3)$$

This represents a linear relationship between the induced velocity and model speed, as was found in the experiments, and manipulation of this equation to provide as close a fit as possible to the numerous experimental curves enabled suitable values of the constants $k$, $C_v$ and $C_t$ to be derived as follows :

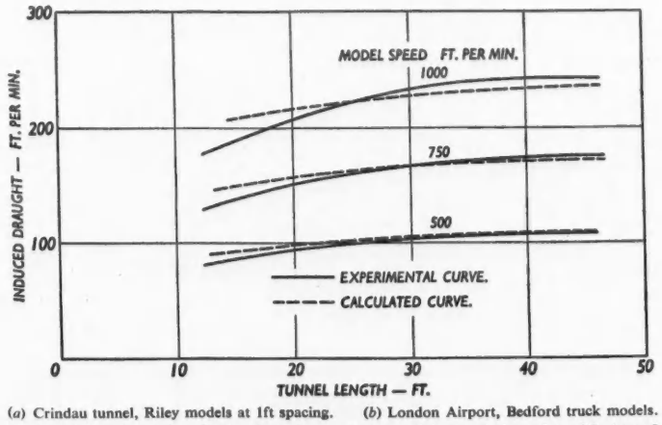
The theoretical curves are shown superimposed (dotted) on the experimental curves in the examples shown in Fig. 13. Similar satisfactory agreement was obtained for all the test results.

The experimental results on the London airport model, whilst used to confirm the theoretical approach, were intended primarily for comparison with the full-scale tests. This was done and Fig. 7 shows, superimposed on the full-scale results, a predicted curve for zero atmospheric wind based on the model experiments. It is apparent that a scale factor of unity is acceptable for relating model and full-scale work.

*Carbon Monoxide Contamination in the Crindau Tunnel.*—With the scale factor established and with a knowledge of typical values of CO exhaust discharge from various types of petrol-engined vehicles,[1, 3] the theoretical analysis was applied directly to

TABLE II—*Derived Values of $C_v$, $C_t$ and $k$*

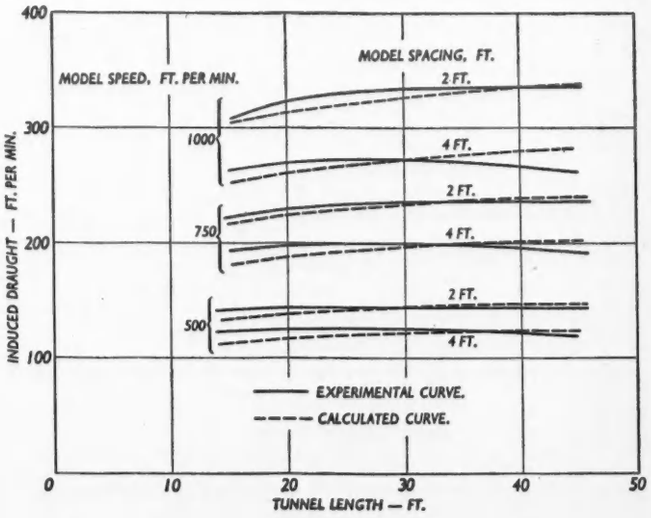
| Models | Model spacing | $C_v$ | $C_t$ | | $k$ |
|---|---|---|---|---|---|
| | | | Crindau | London Airport | |
| Riley saloon cars ... ... ... ... ... | 1ft | 0·50 | 0·0155 | 0·0134 | 1·0 |
| | 2ft | 0·605 | 0·0155 | 0·0134 | 1·0 |
| | 4ft | 0·798 | 0·0155 | 0·0134 | 1·0 |
| Bedford trucks ... ... ... ... ... | 2ft | 1·18 | 0·0155 | 0·0134 | 1·0 |
| | 4ft | 1·48 | 0·0155 | 0·0134 | 1·0 |




(*a*) Crindau tunnel, Riley models at 1ft spacing. (*b*) London Airport, Bedford truck models.

**Fig. 12 (*a*)—Examples illustrating the variation of induced draught with tunnel length**

**Fig. 12 (*b*) (Right)—Examples illustrating the variation of induced draught with tunnel length**



the full-scale Crindau tunnel to predict the likely maximum CO contaminations (at exit) for various traffic conditions in various tunnel lengths.[8] These are shown below in tabular form.

It will be seen that in Table V the example has been taken of heavy vehicles, closely spaced, with a low drag coefficient. These are most arduous operating conditions in which CO contamination would be expected to be very high. In Tables III and IV also, low values of drag coefficients appropriate to close vehicle spacings have been taken which lead to higher values of CO contamination than might normally be expected.

TABLE III—*Light Vehicles* ($A_v$=20 *Square Feet*, $C_v$=0·5)

| Vehicle spacing, feet | Tunnel length, feet | Vehicle speed, feet/minute | CO contamination, parts per 10,000 by volume |
|---|---|---|---|
| 49 | 1000 | 1000 (~11 m.p.h.) | 0·95 |
| | | 4000 (~45 m.p.h.) | 0·89 |
| 49 | 2000 | 1000 | 1·78 |
| | | 4000 | 1·67 |
| 49 | 3000 | 1000 | 2·61 |
| | | 4000 | 2·46 |
| 49 | 4000 | 1000 | 3·51 |
| | | 4000 | 3·30 |
| 25 | 1000 | 1000 | 1·43 |
| | | 4000 | 1·35 |
| 25 | 2000 | 1000 | 2·70 |
| | | 4000 | 2·57 |
| 25 | 3000 | 1000 | 3·96 |
| | | 4000 | 3·78 |
| 25 | 4000 | 1000 | 5·32 |
| | | 4000 | 5·08 |

TABLE IV—*Medium Vehicles* ($A_v$=40 *Square Feet*, $C_v$=1·0)

| Vehicle spacing, feet | Tunnel length, feet | Vehicle speed, feet/minute | CO contamination, parts per 10,000 by volume |
|---|---|---|---|
| 49 | 1000 | 1000 | 0·94 |
| | | 4000 | 0·873 |
| 49 | 2000 | 1000 | 1·78 |
| | | 4000 | 1·66 |
| 49 | 3000 | 1000 | 2·62 |
| | | 4000 | 2·45 |
| 49 | 4000 | 1000 | 3·52 |
| | | 4000 | 3·29 |
| 25 | 1000 | 1000 | 1·49 |
| | | 4000 | 1·40 |
| 25 | 2000 | 1000 | 2·86 |
| | | 4000 | 2·70 |
| 25 | 3000 | 1000 | 4·25 |
| | | 4000 | 3·98 |
| 25 | 4000 | 1000 | 5·65 |
| | | 4000 | 5·34 |

TABLE V—*Heavy Vehicles* ($A_v$=60 *Square Feet*, $C_v$=0·5)

| Vehicle spacing, feet | Tunnel length, feet | Vehicle speed, feet/minute | CO contamination, parts per 10,000 by volume |
|---|---|---|---|
| 49 | 1000 | 1000 | 1·74 |
| | | 4000 | 1·54 |
| 49 | 2000 | 1000 | 3·30 |
| | | 4000 | 2·95 |
| 49 | 3000 | 1000 | 4·82 |
| | | 4000 | 4·33 |

Inspection of the CO contamination levels calculated shows that for all but the most arduous traffic conditions in the longer tunnels (3000ft and over) the predicted CO contamination is below 4 parts in 10,000.

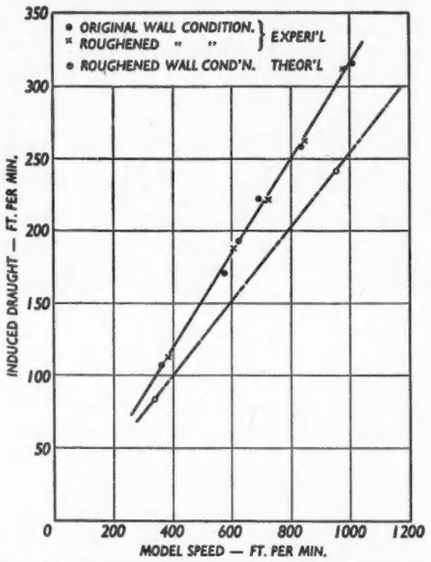



**Fig. 13—Effect of varying wall roughness using the Crindau model at a length of 46ft**

As the proposed full-scale Crindau tunnel length is only 1120ft it is concluded, therefore, that it would be self-ventilating under normal traffic flow conditions embraced by the test results. It should be borne in mind, however, that the predicted results are those under still air atmospheric conditions and continuous traffic flow. Adverse wind conditions, stagnant traffic, and other abnormal effects would vitiate the predictions made.

Whilst this investigation has been primarily concerned with tunnel ventilation to control toxic gas contamination, it should be remembered that the continual increase of diesel-powered vehicles may introduce a further problem.

The CO discharged from such vehicles is very much less than from vehicles fitted with petrol engines, but frequently due to incorrect engine adjustment, considerable quantities of dense exhaust smoke are discharged. It is possible that the inconvenience resulting from this may require a re-assessment of the amount of ventilation required in a tunnel for the safe movement of traffic.

## Conclusions

The foregoing work shows that in the absence of abnormal conditions self-induced ventilation is practicable in road tunnels of moderate length carrying single-direction traffic.

The orientation of the tunnel and the topography of the landscape around the tunnel exit are factors to be considered when assessing the effect of external wind conditions. Traffic hold-ups in the tunnel might also cause serious contamination.

Thus it would be unwise to build a busy tunnel of moderate length with no provision for forced ventilation. Since self-ventilation could confidently be expected to be satisfactory for long operating periods, however, a simplified forced system might be employed for emergency use only. Such a system could be operated automatically when the CO contamination reached a specified level.

## Acknowledgments

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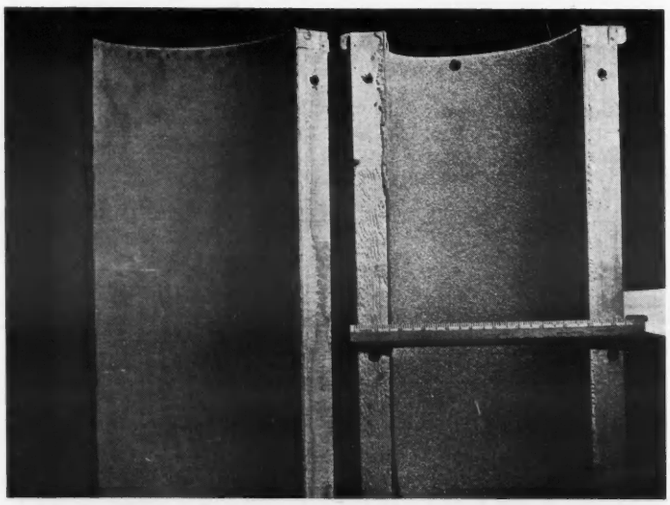


**Fig. 14—Original and roughened tunnel walls**

# SHORTER REPORTS

## Isotope Information Bureau

RADIOISOTOPES have a far wider field of application in industry than is generally realised, and to promote their use in the most effective and economic manner the United Kingdom Atomic Energy Authority has set up an isotope information bureau at its London office, 11, Charles II Street, S.W.1. The bureau was opened on June 16 by Sir Roger Makins, chairman of the U.K.A.E.A., who said that while competitive economic atomic power was on the way, the radioisotope had already arrived. Much work remained to be done in the field of radioisotope technique. More new methods of application had still to be discovered, tested and applied, but the Authority now had sufficient knowledge and experience to offer with confidence to industry a number of products which would improve manufacturing techniques and quality control. The information bureau was a further step in their programme. He hoped that it would help to disseminate, to a very wide audience, the advantages to be gained in so many fields of human endeavour by the use of radioisotopes.

Sir Hugh Beaver, acting president of the Federation of British Industries, spoke of the difficulty of getting people to use research. Too many firms were content to rely on their own craftsmanship and were too little aware of the growing competition facing this country. If we could not show ourselves more competent than the rest of the world, our way of life, our standard of living, our own supremacy in the industrial world were challenged. In radioisotopes we now had a new weapon of proved capacity which probably could be used in every sort of productive and creative activity in this country, and management must ensure that its experts and technicians kept themselves informed of how it could be applied.

The information bureau is equipped and staffed for providing visitors with a basic introduction to the uses of isotopes by means of literature, instructional films, and exhibits. Advice is given on reference works for further study of the subject, and inquirers seeking detailed information can be put in touch with the appropriate departments of the U.K.A.E.A. Applications for the use of isotopes are carefully investigated to ensure both that they are in fact a suitable medium for the work required, and that they will be applied in appropriate conditions with respect to safety. Exhibits in the bureau at the present time include a working demonstration of thickness gauging, and a model illustrating how the effect of wind, waves and tides on coast erosion was studied by tracing the movements of pebbles treated with barium lanthium.

## Institute of Sewage Purification

THIS week the Institute of Sewage Purification has been holding its annual conference at Scarborough. About half a dozen papers have been discussed (the conference ends to-day), some of which bear on engineering matters. For instance, Dr. Chambers' paper on " Fuel Cells and their potentialities for power generation from sludge digestion gas " dealt with a promising future development. The author pointed out that inasmuch as all the fuel cells under development to-day were designed to run on gaseous or vaporised liquid fuels, they were in principle well adapted to power generation from sludge digestion gas. There were no special problems associated with that application, and almost everything that could be said about operating fuel cells on sludge gas was true also of cells running on any other gaseous fuel. Fuel cells had only recently passed beyond the laboratory stage of development and it was still too early to answer all questions regarding the economics of that method of electricity production. Development of commercial fuel cell installations was likely within the next three or four years. At the worst that would be a useful addition to methods of generating electricity for special purposes ; at the best it could lead to a major revolution in methods of power production.

Fuel cell installations large enough to be of interest for power production at sewage works, Dr. Chambers concluded, were not likely to become commercially available for a number of years. There were many smaller applications to be exploited first which would enable experience to be gained on long-term performance and the general problems of control equipment. The transition to larger sizes of, say, 100kW upwards should be comparatively easy, because the system lent itself naturally to scale-up by multiplication of identical modules. For larger outputs radical redesign was not necessary and in fact it was no more difficult to design a 500kW installation than one of 50kW.

Another topic of widespread interest to-day, though one concerned more intimately with the chemical side of sewage purification, is that of detergents, and a symposium of five papers called " Progress towards the solution of the synthetic detergents problem " formed a notable part of the conference agenda. In his introductory paper Dr. Key pointed out that the Jephcott Committee had recommended that " manufacturers of household synthetic detergents should investigate the feasibility of producing efficient washing products based on materials which can be readily oxidised or eliminated, and will not cause persistent foaming, during sewage treatment by present available methods." He went on to say that manufacturers had not been slow to accept that recommendation and the investigations reported in subsequent papers of the symposium stemmed from their efforts in that direction. A new alkylaryl sulphonate (it would be more correct to say a new mixture of these) had been developed and tested, first on the small scale and finally on a very large scale indeed.

It was quickly established that the new surface active material (labelled JN) had a considerably higher B.O.D. than the old (labelled PT) and that, at the end of the B.O.D. test, the amount of active material remaining (by the Longwell and Maniece method) was much smaller. It was decided to seek confirmation of its greater oxidisability thus indicated by treating it with sewage on small-scale biological filters and activated sludge units. Meanwhile, in anticipation of this confirmation, the manufacturers offered to arrange for all packeted synthetic detergents distributed to a selected area to be based on JN instead of PT for a period of up to a year, so that its behaviour on the large scale, both at sewage works and in a stream, could be examined. The Luton-Harpenden area appeared to have all the advantages. It was acceptable to the manufacturers, who had the difficult job of arranging distribution ; it was conveniently situated in relation to the Water Pollution Research Laboratory and the Laboratory of the Government Chemist, who undertook to do the necessary sampling, analyses, photography, &c. ; the Luton and Harpenden works were of different types ; and the effluent gained but little dilution on discharge, so that observation could readily be made on the receiving River Lee for several miles before sewage effluents from districts outside the chosen area were made into it. Preliminary observation commenced in June, 1958, and the changeover to the new detergent commenced in August of that year.

The Luton experiment had broadly confirmed that JN was more oxidisable than PT, Dr. Key pointed out. More conclusive evidence awaited the more complete replacement of PT in use in the area. To this end manufacturers had now increased the area covered by the new product, and one of them had begun distribution of it over the whole of the Southern half of England. Further results would no doubt appear in the next report of the Standing Committee.

### PRESIDENTIAL ADDRESS

On Tuesday the Institute's new president, Mr. M. A. Kershaw, who is general manager of the West Hertfordshire Main Drainage Authority, delivered his address. Concerning trade effluents he referred to the guidance and assistance members had provided to local authorities in solving the many problems arising from the introduction of new industrial processes. He regarded the formation of the Trade Effluents Sub-Committee of the Central Water Advisory Committee as the most important step forward in this field since the war, and said its recommendations, if acted upon, would establish a great advance in the effective control of industrial effluents.

Turning to research, both in sewage and trade effluent treatment problems, Mr. Kershaw referred to the need to put, wherever possible, waste products to gainful use, and also to the need for research into means of further mechanisation and automation of treatment plant.

Perhaps nowhere was research more needed than into the problems of sludge disposal. He had been led to the conclusion that in some measure there had been a failure to the community in neglecting to tackle in a purposeful manner the question of the complete treatment and economic disposal of sludge. Sewage, even with industrial wastes, could now be treated to almost any degree required, but this very success had aggravated the already difficult problem of complete sludge disposal. He criticised the common statement, in describing sewage works, of " sludge disposal by drying beds." That was not a method of sludge disposal, but only a stage. The only complete disposal was the distribution direct to land of digested sludge as a manure, but he admitted that many difficulties were to be encountered in its use. Land was daily becoming more scarce, and he deplored that in remodelling sewage works land held for that purpose had often been disposed of for other uses. That policy was short-sighted, and he suggested that a review of the general position concerning sludge disposal would reveal that very few sewage treatment departments could truthfully claim that their sludge disposal facilities were satisfactory. Many new plants had, from their commencing operation, been faced with serious difficulties relating to sludge disposal, and it was fundamentally wrong to accept this as a perpetual problem.

He then reviewed the present methods of sludge disposal available, and concluded by stating that the need for large-scale research into the problem was urgent, for if rivers were to become wholesome at all times, greater quantities of polluting matter must be removed from the waste waters reaching them, and that matter, as sludge, must be disposed of satisfactorily.

Mr. Kershaw turned then to the need for the adequate training of younger members in management in addition to the technical side of sewage treatment, and welcomed the inclusion in the Institute's examination syllabus of a section on that subject. Such a broad subject as sewage treatment required managers of works to have a breadth of vision, and local authorities would be best served by such managers in complete charge of their departments, responsible directly to the councils. And, in discussing training, he advocated the spending by design engineers of at least a year working on a sewage works, learning the operational duties ; that should lead to future works being designed in a more trouble-free manner.

# SHORTER REPORTS *(Continued)*

## The Minister of Housing on Clean Rivers

MR. HENRY BROOKE, Minister of Housing and Local Government, made some remarks about clean rivers when he opened the new sludge digestion plant of the Birmingham Tame and Rea District Drainage Board at Minworth, Warwickshire, last Friday. His ambition, he said, was to be the " Minister for Clean Rivers," and his motto was " Less filth, more fish." The pollution of the Tame had been so bad, he said, that, where it flowed into the Trent, it caused fish life to disappear for 10 miles downstream, though fish had come back to the Trent above the point where the two rivers joined. The biggest contribution towards improvement would be the comprehensive scheme of which the sludge digestion plant he had opened was an instalment. Specially difficult trade wastes had to be dealt with, and the drainage board had applied themselves to the problem with real success.

Water and drainage, the Minister continued, attended to facts of geography and levels ; neither of them paid much attention to local government boundaries. Yet whereas the idea was now fairly generally accepted of trying to regroup water undertakings into areas more closely related to natural water areas, there had so far been less breadth of vision in most places as regards sewage disposal. The demands on our rivers were increasing all the time, he said, and a report by a sub-committee of the Central Advisory Water Committee published last week had said that the time had come to introduce a control over abstractions of surface water, as efficacious as the control that already existed over abstractions from underground sources. The hydrological surveys of certain river basins carried out by the Surface Water Survey Centre tended to endorse the sub-committee's conclusions.

For some rivers at any rate, Mr. Brooke went on, it might be that nothing short of a plan for the river basin as a whole would serve to reconcile all demands, and determine the right measures for conserving and regulating river flow while making as much water available for use as possible. There were those who recommended the establishment of river authorities to deal with everything that was taken out of our rivers as well as everything put into them. Such matters were being considered, he said. However, it would have been premature to have commented about the draft proposal by the Local Government Commission that a still larger authority to tackle sewage disposal was needed for the West Midlands as a whole.

The sludge digestion plant at Minworth works which Mr. Brooke opened consists of sixteen 80ft diameter sludge digestion tanks, equipped with gas collectors, and with sludge-heaters fired by the gas thus obtained. The plant was built to the designs of the chief engineer of the Birmingham Tame and Rea District Drainage Board, Mr. M. R. Vincent-Daviss M.I.C.E., by the main contractor Tarmac Civil Engineering, Ltd., at a cost of about £850,000.

## Medway River Bridge on the Proposed M.2

A CONTRACT has been let for the construction of a large prestressed concrete bridge which will carry the Medway Towns motor road over the River Medway. Mr. Ernest Marples, Minister of Transport, has awarded the contract, amounting to £2,325,931, to J. L. Keir and Co., Ltd., in association with Christiani and Nielsen, Ltd., for the construction of the bridge and approach viaducts. The consulting engineers for the bridge are Messrs. Freeman, Fox and Partners. Its construction will take about two and a half years, and work on the M.2 itself, which will take less time to complete, will begin later. M.2 is the most important motorway project in south-eastern England ; it will leave A.2 on the London side of Strood, and will be 25 miles long, by-passing to the south Rochester, Chatham, Sittingbourne and Faversham, then rejoining the existing route to Canterbury, Dover, Folkestone and other Kent coastal resorts.

The Medway bridge, with its approach viaducts and their abutments, will be nearly two-thirds of a mile long (3270ft) with a central span of 500ft, 100ft above the river. Two additional river spans—one on each side of the centre span—will give the bridge itself a total length of 1125ft. The western approach viaduct will have eleven spans and the eastern viaduct seven, making twenty-one spans in all. The bridge will carry two carriageways, separate cycle tracks and footways.

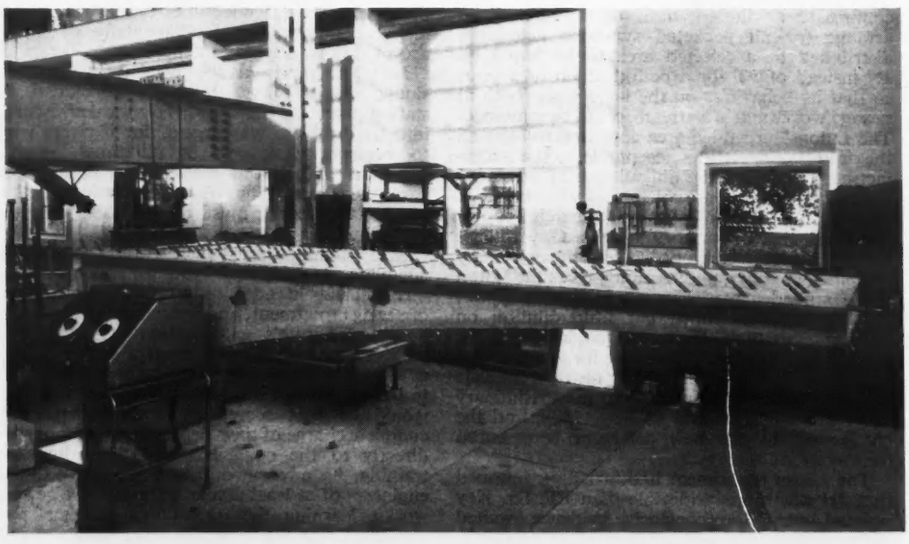
The main span of 500ft will be the longest in the world in prestressed concrete ; Coblenz bridge over the Moselle completed in 1954, has a main span of 403ft, and the Rhine bridge at Worms, built in 1953, has a main span of 375ft. As with these two bridges, a cantilever method of construction is to be employed, formwork, together with essential plant, being moved forward on steel or aluminium travelling cages.

At the main piers excavation inside sheet-steel-piled cofferdams will have to be taken down some 50ft below high water to reach the chalk bedrock. After the mass concrete foundations are brought above water level, the comparatively slender cellular reinforced concrete piers will provide the seatings from which the main span and side anchor spans will be cantilevered outwards in both directions.

The superstructure will consist of independent twin bridges. In the central span 200ft long cantilevers will support a 100ft suspended span. The overall depth of the beams will be about 35ft at the river piers and 8ft at the centre. Both the anchor and cantilever spans will be of cellular construction. The suspended span of each of the twin bridges will consist of four precast prestressed concrete beams weighing up to 95 tons each, supporting a reinforced concrete deck slab cast *in situ*.

The 2145ft of approach viaducts will consist of reinforced concrete slabs cast on precast prestressed concrete beams weighing up to 185 tons each. These will be supported by reinforced concrete portal piers founded on piles or on spread footings.

The Prestressed Concrete Development Group has issued a statement about the bridge, which asserts that the amount of the contract for a prestressed concrete bridge has proved the overall economy of prestressed concrete for bridges of spans far greater than had hitherto been considered economically possible. The difference in initial cost of building the Medway bridge in prestressed concrete rather than steel, it is stated, is appreciable, with considerable future saving in maintenance costs. Model testing was employed by the Cement and Concrete Association at the request of the consulting engineers to investigate the effect of certain novel features which the consultants proposed to incorporate in the design. These tests were carried out on an approximately one-thirteenth scale model in concrete of part of the bridge which we illustrate herewith.



**Approximately 1/13th scale structural model in concrete of a cantilever of Medway Bridge, under test**

## B.B.C. Television Centre

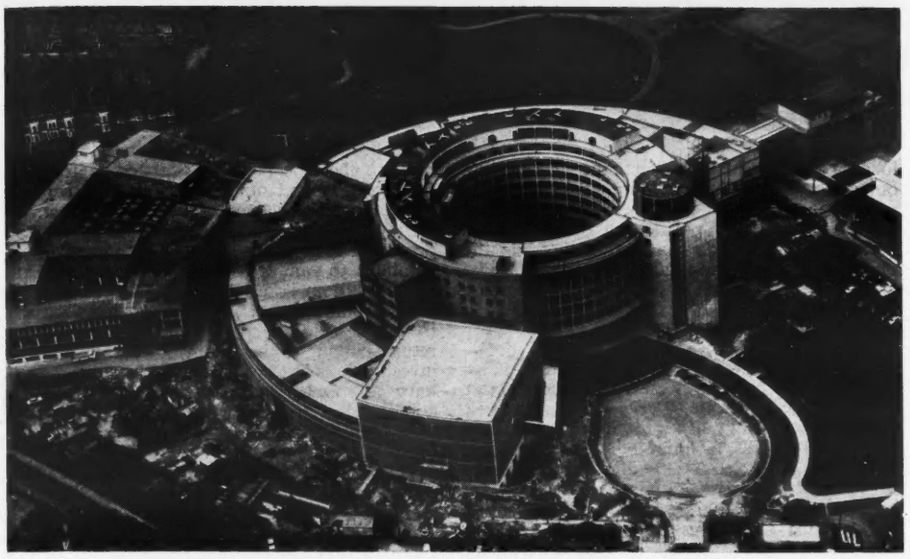
THE main block building of the B.B.C. Television Centre, Shepherd's Bush, London, is now structurally complete and one of the studios is ready for service. This studio will be used for programme transmission for the first time on June 29.

Building of the main block, containing seven studios, two presentation studios, technical areas, dressing rooms and offices, was begun in 1955. The presentation suite will shortly be in operation ; another studio will be ready in the autumn and two more and the second presentation studio by the summer of next year. The remaining three, already erected in shell form, will be equipped at a later stage.

The main block will depend for its ultimate aesthetic effect on a spur to contain more offices and operational areas which has yet to be designed and built. A services block, to be known as the east block, will be begun in 1961.

We illustrate the main block as it is to-day, pending addition of the office spur which will be erected in the right foreground. The building, covering 3½ acres, consists of a circular inner ring, nine storeys in height, surrounding a central garden courtyard, 150ft in diameter, and ranged about by seven television production studios, their ancillary areas, and a wedge-shaped multi-storey control block.

The architect for the work is Mr. Graham Dawbarn, C.B.E. (of Messrs. Norman and Dawbarn), in association with M. T. Tudsbery, C.B.E. (Consulting Civil Engineer to the B.B.C.). Sir Howard Robertson, A.R.A., P-P.R.I.B.A., and Sir William Holford, M.A., F.R.I.B.A., are architectural consultants for the scheme. Main contractors are Higgs and Hill, Ltd.,



**Completed portion of the B.B.C. television centre at Shepherd's Bush**

Crown Works, South Lambeth Road, London, S.W.8, for superstructure of the main block, scenery and restaurant blocks ; and George Wimpey and Co., Ltd., Hammersmith Grove, London, W.6, for the foundations and retaining walls of the main block.

In the technical control areas the control rooms for vision, lighting and sound lie behind continuous plate glass windows extending across the inner end of each studio, and behind these are the apparatus rooms. It has been proved possible by a comprehensive series of experiments for one operator at the vision control console to control electrically all the cameras in a studio, which may be as many as six. This has been achieved, first, by arranging the controls and picture monitors in such a way that minimum effort is required by the vision control supervisor ; and secondly by designing the cameras and their associated equipment for remote control. This necessitates a very high degree of electrical stability, but it has been proved that an image orthicon camera channel can be used in this way with only two operational controls—one varying the light input, by means of a remotely-controlled iris, and the other the picture black level. The remaining controls, numbering about thirty, are pre-set in advance.

The operational controls in the vision control consoles have been developed to enable three functions to be performed with a single control. Moving the control over a quadrant varies the lens aperture ; a knob on the control is rotated to adjust the picture black level ; and pressure on this knob will switch a single monitor from one camera to another. Each camera has, as usual, its own picture monitor and this last facility enables the pictures from each of the cameras to be displayed in turn on a single pre-view monitor so that the pictures can be accurately matched, eliminating possible differences in individual monitors.

Alongside each picture monitor is a waveform monitor developed for operational checking of voltage levels. This unit is extremely compact, having a width of only 3½in, achieved by using a 5in × 2in rectangular cathode-ray tube mounted with its major axis vertical. The waveform display is about 5in high and can be seen easily from a distance of 5ft, but the time scale is compressed to about 1¾in. This is of little importance, as the vision controller is mainly interested in setting correct voltage levels. To facilitate this, the monitor includes an electronic cursor which superimposes on the display a line corresponding to white level. This line, which is traced during the field suppression period, and black level, which appears during each line suppression period, give the two limits of the signal excursion.

Each studio camera incorporates a 4½in image orthicon pick-up tube. Turret mounted lenses provide nominal horizontal viewing angles of 9 deg., 16 deg., 24 deg. and 35 deg. Newly developed studio zoom lenses are also available ; they are turret mounted and cover horizontal viewing angles in the range 9 deg. to 32 deg. Cameras, picture monitors and inlay equipment have been supplied by Marconi's Wireless Telegraph Company, Ltd., Chelmsford ; camera equipment by E.M.I. Electronics, Ltd., Hayes ; and picture monitors by Pye, Ltd., Cambridge.

The control apparatus room forms part of the presentation suite and is the focal point to which are brought and from which are distributed vision and sound signals from the local studios, telecine and video tape reproducers, and external sources. Comprehensive facilities are provided for monitoring and measuring the television signal at various stages of the programme chain, and line terminal equipment is provided for vision links between the Television Centre and the switching centre at Broadcasting House ; and between the centre and other London studios. In addition, the main power control board is installed in this area and it is possible to monitor the power intake to the site and control its distribution by remote control of the 11kV switchgear.

The production lighting installation is broadly similar to that at the Riverside Studios, but provision has been made for panning, tilting and focusing luminaires by means of a pole from the studio floor in order to reduce the time required for producing a desired lighting pattern. Intensity control and switching of every studio light source are possible from a centralised control desk with presetting facilities enabling the majority of lighting changes to be effected by operating a single pushbutton.

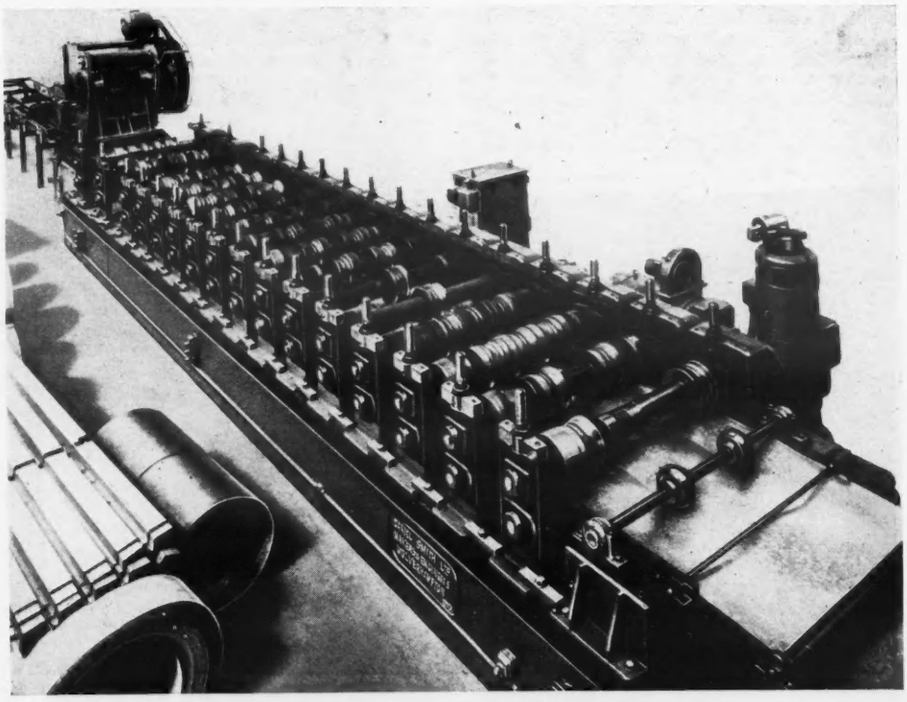
Electricity supplies to the site are taken from the London Electricity Board at 11kV. Estimated maximum demand for the initial development is between 3·5MW and 4·0MW. The normal supply is via two 0·25 square inch 11kV underground cable trunk feeders direct from the Electricity Board's substation. These two feeders are to be operated as a closed ring to supply three high-level 11kV substations situated around the periphery of the main studio block above the scenery runway. Balanced pilot feeder protection is being provided on all the 11kV cables forming the ring, including the two trunk feeders from the Electricity Board's substation. All these cables are capable of carrying the full load of the site. An emergency supply, also at 11kV, is available in the event of a fault causing simultaneous failure of both normal supplies.

For production lighting purposes, in addition to the normal a.c. supply, a 110V d.c. supply for arc lighting in back projection equipment is fed to each studio from 55kW germanium rectifiers. Separate 110V d.c. germanium rectifiers have been provided for camera dolly motors and similar mobile motorised equipment.

## Rolling Mill for Roofing Sections

A ROLLING mill has been designed and built by Daniel Smith, Ltd., Castle Iron Works, Peel Street, Wolverhampton, for the production of Anderson roofing sections up to 54in wide, from 20 and 22 gauge galvanised steel sheet. This design of roofing section has five 2½in deep channels of special shape along its length and the new mill develops the channels in a continuous run from coiled stock in its sixteen roll stations. A flying cut-off cropping press built in-line with the mill is arranged to shear the sections in required lengths from 4ft to 30ft without stopping rolling procedure. The general lay-out of the mill can be seen in the photograph we reproduce of the machine undergoing acceptance tests in its maker's works.

The sixteen stands of the mill are mounted at 18in centres along a heavy steel plate table which



**Sixteen-station rolling mill for roofing sections**

## SHORTER REPORTS *(Continued)*

is some 30ft long and carried on a rigid framework of welded steel sections. The drive is provided by a 54-10 b.h.p. at 1500-300 r.p.m. commutator motor and induction regulator coupled to a double helical, 5 to 1, reduction gearbox. This power unit is situated at one side half way along the length of the mill, and drive from the gearbox is transmitted by a triplex chain to a short intermediate shaft set in the lower part of the mill base frame. This intermediate shaft is geared to the lineshaft of the mill and the lineshaft drives the main wormshafts of the roll stands through four spaced sets of gearing. The wormshafts of the geared heads of the stands are coupled together in four groups by roller chain couplings. By the use of four sets of gears spaced along the lengths of the coupled wormshafts to transmit the drive, the full driving torque is exerted simultaneously at all stands upon starting and during rolling.

The roll stands have the maker's " Multiversal " design of driving heads in which drive from the main wormshaft is transmitted directly to the lower roll spindle and through gearing to the upper roll spindle. A pair of intermediate spur gears through which the drive is taken to the upper spindle are carried on a toggle lever assembly. This toggle assembly provides the necessary movement for upper roll height adjustments whilst maintaining full tooth contact over the permissible range of 3⅜in, which allows top and bottom spindle centre settings between 5¼in and 9⅜in. The gearing in each of the heads is arranged to give a top roll speed 1·3 times faster than the lower roll speed.

All of the roll spindles and transmission gearing are mounted on roller bearings to reduce frictional losses to a minimum, and the lower halves of the gear heads provide oil baths for the gears. The 4in diameter spindles carry built-up roll clusters, the maximum roll width being 54in and the mean roll diameter 8in. Based upon this mean roll diameter the strip speed through the mill is variable between 95ft and 19ft per minute. All bearings and other moving parts throughout the mill have automatic grease lubrication.

At the feed end of the mill the coil stock is nested and freely rotates on rollers in a cradle, set at floor level to facilitate loading and feeding into the mill by hand-operated pinch rolls. The cropping press at the outgoing end of the mill works in a timed relationship and its stroking can be set in accordance with the required roofing section lengths. The cropping tool assembly is mounted on slides in the press. In these slides the tool can be moved rearwards against spring loading when its blade contacts the strip passing out of the mill. The cropping stroke and ram return movements are completed before the tool reaches its rearmost position in the slides, and immediately the blade has cleared the strip the spring returns the tool along its slides to its operative position ready for the next cropping cycle.

[Reply Card No. E10771]

### Motor Industry Research

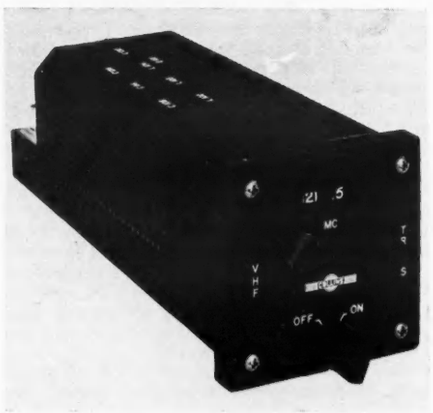
THE Motor Industry Research Association at Lindley, near Nuneaton, Warwickshire, last week opened to visitors its proving ground and laboratories. New facilities to be seen were large and small open-circuit closed-jet wind tunnels, respectively 26ft by 14ft 6in and 6ft 9in by 3ft 4½in. As is well known, the measurement of aerodynamic derivatives of road vehicles in a wind tunnel is rendered difficult by the boundary layer on the tunnel floor, and devices to eliminate this source of error, such as mounting the model on a short platform, become cumbersome for large test pieces. However, to study the behaviour of the induction, exhaust, cooling, and ventilating systems and the noise generated by the air flow it is valuable to be able to test real vehicles, and so a large tunnel with a chassis dynamometer was undertaken. For convenience in installing vehicles, the floor of the tunnel is the floor of the building, so that the floor conditions are not realistic and, in particular, brake cooling effects cannot be simulated. Since accurate aerodynamic derivatives are not expected to be observed, the cost of the facility has been reduced by limiting the speed to 80 m.p.h. The tunnel commences with a short flare on walls and roof leading to a coarse straightening grid : there is then a slight and gradual contraction to the long working section. The diffuser diverges to four fans : these are in fact de Havilland " Hydromatic " airscrews, but because they are very much underloaded—total power is 1300 h.p.—the variable pitch provision is not used and the tunnel has only nine pre-set speeds. The chassis dynamometer consists of two large steel drums mounted on an Eaton two-speed axle, the torque developed being measured directly : to allow this the axle casing is supported on rolling bearings with provision for rotating the races to protect them from Brinelling (the weight of the powered wheels is carried by these bearings). The power is taken by a universally jointed shaft into the output end of an epicyclic booster from a Foden twelve-speed gearbox, and absorbed in a fan-cooled electric motor : the axle is mounted back to front, so that torques and not speeds are negative with respect to design values. There is also, upstream from the dynamometer, a six-element aerodynamic strain gauge balance, mounted on a turntable to yaw with the test piece. Automatic digital readout is provided.

The smaller tunnel, roughly ¼ the size, is in the same building, so that each tunnel is in the return circuit of the other. It is intended for investigations at low Reynold's Number, and will have a speed range of 20—80 m.p.h. when completed.

**The floor of the wind tunnel is that of the building, so that when real vehicles are tested they are easily emplaced: simulation of the air flow past a moving vehicle is not attempted.**

### Anglo-American Radio Partnership

EXAMPLES of radio and data transmission equipment to be manufactured in this country by L.C.E., Ltd., Electral House, Neasden Lane, London, N.W.10, were exhibited in London last week. The company is an Anglo-American partnership jointly owned by Joseph Lucas (Industries), Ltd., through G. and E. Bradley, Ltd., and the Collins Radio Company of America. In the light of recent discussions on the standardisation of air navigational aids, items of special interest from the Collins range of airborne equipment were installations providing both v.h.f. communications and VOR/ILS navigational facilities for airline and private aircraft. In the airline apparatus the communications receiver works in conjunction with an instrumentation unit to provide bearings from VOR beacons and landing aids from ILS localiser beacons, while full ILS service is available in conjunction with a separate u.h.f. glidepath beacon receiver.




**Aircraft 90-channel v.h.f. transmitter for instrument panel mounting**

We illustrate a lightweight transmitter (17L-8A) for private and business aircraft, providing ninety crystal-controlled channels in the 118-126·9 Mc/s range. This unit, complete with its controls for operation by the pilot, can be mounted in a normal instrument panel cut-out and a companion receiver (51X-3) with similar front panel presentation may be mounted beside it. The receiver will provide reception of VOR beacons, with bearing indication on a separate unit, and also of ILS localiser beacons. Power supplies are taken from a power and amplifier unit which is fully transistorised.

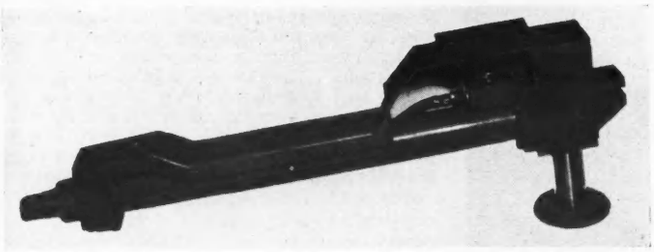
The Collins organisation has also been active in developing single-sideband equipment, and among apparatus in this class which may now be manufactured in this country by L.C.E., Ltd., are a ground mobile transceiver (32M-1) of 100W p.e.p. output for operation on supplies of 18V or 28V d.c. or 115V/230V a.c., 50/60 c/s.

Another class of equipment exhibited was the " Kineplex " high-speed data transmission system for working over landline, cable, microwave radio and tropospheric scatter links.

[Reply Card No. E10782]

## Lifters for Armoured Face Conveyors

THE Central Engineering Establishment of the National Coal Board, in collaboration with the staff of Bestwood Colliery, Area No. 6, East Midlands Division, has designed and manufactured a conveyor lifter to enable quick and easy elevation of armoured face conveyors for horizon fixing and for inspection of the chain on the return side of the pans. The equipment used to advance an armoured face conveyor horizontally comprises double-acting rams powered by a water emulsion pump located in the gate road, whilst the vertical lift required to fix the horizon is usually effected by a commercial design lifting jack. This method has disadvantages in that operation of the jack is the full-time occupation of one man on each face and in the event of a breakdown with only one jack on the face it often takes a full shift to locate the point where the chain is broken or staked.



Armoured face conveyor ram with integral lifting jack extended

The Bretby conveyor lifter consists of a jack combined with a ram, so that the single piece of equipment can be used for all the required operations. Our illustration shows the jack combined with a " Bonser " ram, but any other type of ram could be used as the basis of the conversion. The jack has a malleable iron housing, on the front of which is integrally cast a slotted lug for attaching the jack to a standard spill-plate. To adapt a standard " Bonser " ram to take the jack, the two lifting lugs are removed and a smooth vertical face machined on the ram head. Four capscrews are then used to mount the jack as shown in the illustration. The standard valve housing is replaced by a new unit incorporating extra drillings to perform the additional functions. Operation of the control handle gives the following sequence of operations : extend ram with jack retracted, retract ram with jack retracted, elevate jack with ram retracted, retract jack with ram retracted.

In all positions the underside of the jack piston is fed from the pressure supply to ensure that when the top of the jack is open to exhaust there is sufficient pressure on the underside to oppose return line back-pressure which would otherwise elevate the jack. The double-acting jacks used each have a stroke of 6in and, with a fluid working pressure of 1000lb per square inch, can raise just over two tons.

The usefulness of the installation has been proved by experience underground at Bestwood Colliery, where one face is fully equipped with thirty rams. On this face the combined units are set at 7-yard intervals and the simultaneous operation of three adjacent jacks lifts the conveyor complete, with little catenary effect on the conveyor between the jacks. This facilitates inspection of the bottom chain, and eighty yards of chain have in fact been replaced in only 1¾ hours on this face.

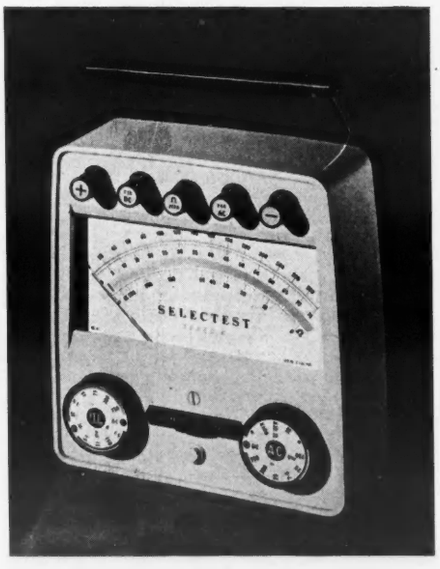
[Reply Card No. E10791]

## World Standards for Protective Helmets

ON the initiative of the British Standards Institution, the Protective Headwear Manufacturers' Association and other safety interests, a new committee of the International Standards Organisation has been set up. The committee is to hold its first meeting later this year at British Standards House in London (October 12 to 14). It will be attended by helmet makers, safety organisations and Government representatives and other experts from many parts of the world. The aim of the committee will be to agree on world standards for the quality and testing of safety helmets. Firms in the United Kingdom believe that as a result of years of research and testing by manufacturers and independent testing laboratories in the U.K. the present British Standards for motor-cyclists', racing car drivers' and industrial workers' helmets are among the highest in the world and they naturally hope that any recommendations which the new international committee evolves will be substantially in line with existing British practice. The London meetings will afford the first real opportunity for an exchange of research data and views on head protection by means of safety helmets and for the promotion of their use.

## Multi-Range Test Sets

COMPLETE redesign in presentation and technical details of the earlier " Selectest " multirange meter has taken place in producing two new " Selectest " models, the " Super K " and " Super 50 ". The " Super K " (illustrated) is available now from Salford Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, 3, and the " Super 50 " will be in production shortly. Germanium diode rectifiers are incorporated for a.c. measurements, and a printed circuit technique has been adopted.




Multi-range a.c./d.c. test set for voltage, current and resistance measurements

Ranges are selected by two rotary switches capable of continuous rotation in either direction without mechanical interlock, the circuits being arranged so that the switches are interlocked electrically. In the " Super K " instrument the voltage ranges are 7·5V to 750V a.c. and 150mV to 750V d.c. Current ranges are 75mA to 7·5A a.c. and 1·5mA to 7·5A d.c. All can be doubled by means of a multiplying switch. Resistance ranges are 0-1000 ohms, 0-10,000 ohms and 0-100,000 ohms. The " Super 50 " meter has voltage ranges from 2·5V to 2500V a.c. and from 250mV to 2500V d.c. To facilitate measurements on d.c. a moving coil reversing button is fitted to avoid changeover of leads. Current ranges with this model are 25mA to 10A a.c. and 50 microamperes to 10A a.c. ; and voltage ranges are 0-2000 ohms, 0-200,000 ohms and 0-20 megohms.

The instruments incorporate an automatic cut-out as a safeguard against overload in the forward or reverse direction. The movement has a critically damped moving coil system on highly polished, hardened steel pivots mounted in spring-loaded conical sapphire jewel bearings, and operating in the gap of an " Alcomax " III permanent magnet. Three scales are provided, with mirror inset and knife-edge pointer. In the " Super K " two scales, 0-75 with seventy-five divisions and 0-300 with 150 divisions, are used for all current and voltage ranges ; and the third, 0-1000 ohms, covers all three ohm ranges. The " Super 50 " current and voltage scales are 0-100 with 100 divisions and 0-25 with fifty divisions. Overall dimensions of the instruments are 7⅝in by 7in by 3½in and the weight is 5 lb 8 oz.

[Reply Card No. E10793]

## Multi-Pole Connectors

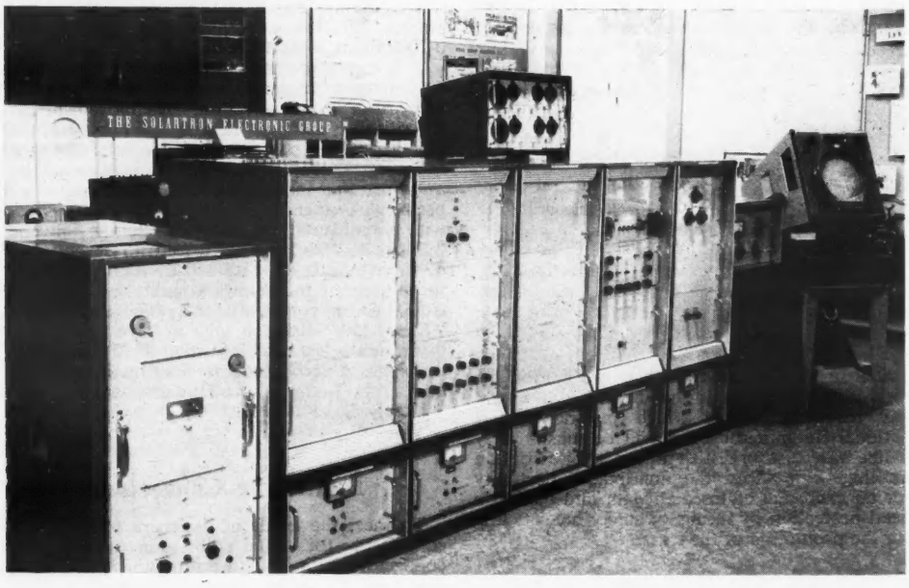
To meet the needs of designers of electronic equipment for multi-pole plug and socket connectors with low insertion and withdrawal force, the " Unitor " device illustrated has been made commercially available from Ferranti, Ltd., Ferry Road, Edinburgh. The " Unitor " is said to be particularly suitable for use with rack-mounted equipment where multiple connections are required at the rear of sub-units, and may also be used with either free plug or free socket.

Plug and socket portions of 70-pole, low-force connector for electronic equipment

A low nominal insertion force of 4 oz per pole is achieved by the construction of the socket clips, the jaws of which are actuated by independent springs. Total insertion force is in direct proportion to the number of poles. The withdrawal force is approximately two-thirds of the insertion force and there is considerable tolerance to misalignment. At present, 35-pole, 70-pole and 91-pole versions of the " Unitor " with silver-plated contacts are in production. All are polarised. Main specification details of all silver-plated " Unitors " are : maximum working voltage, 500V ; current rating 5A ; contact resistance 2 milliohms. Overall dimensions of the 70-pole model illustrated are 1·9in wide by 3·52in long. Similar devices are also being produced with hard gold-plated contacts for use in polluted atmospheres, and offering superior contact performance where extremely low voltages are encountered.

[Reply Card No. E10794]

## SHORTER REPORTS *(Continued)*




**Simulator for radar training connected to an " Escort " display unit (extreme right). The chart scanner is in the foreground, instructor's target ship unit on top of cabinets, and pupil's controls next to radar display**

### Marine Radar Simulator

DEMONSTRATIONS were given in London recently of a simulator for navigational training which has been designed by Solartron Radar Simulators, Ltd., Farnborough, Hants, a subsidiary of the Solartron Electronic Group, Ltd., in the Firth Cleveland Group of Companies. In the cubicle form illustrated, one of these equipments has been sent on a Continental demonstration tour by air, sea and road transport, covering eight countries, in the course of which it was operated for approximately 1300 hours without unserviceability. The apparatus can be supplied for use with any form of radar. It is seen connected to the display unit of an A.E.I. " Escort " radar (see our March 20, 1959, and March 4, 1960, issues). The unit nearest the camera contains the training chart and the scanning equipment by means of which the chart is reproduced on the radar screen. The chart is etched on an opaque plate and placed in the top of the cabinet above a flying spot scanner. At the other end of the equipment is the control panel manipulated by the pupil to simulate navigation of a ship in accordance with the situation shown on the radar screen, including the movements of two " target " vessels which may be fed in by the instructor using the small unit on top of the cabinets. The demonstration showed how the simulator could be applied to provide training in interpretation of the three forms of display available with the " Escort " radar, namely, relative motion with true North at top of screen ; relative motion, " ship's head up " ; and true motion. Manoeuvre characteristics of any ship can be reproduced.

The electronic equipment of the simulator is designed on the modular principle and the drift-corrected amplifiers are mounted in drawers which can be lifted out of the cabinets. Signals are generated by an analogue computing system, into which are also fed the signals from the target ship unit. Thermionic valves are used throughout, but when the apparatus is assembled in the form shown forced cooling is not required. For permanent installation, however, the apparatus might be concentrated in two racks and forced cooling would then be necessary.

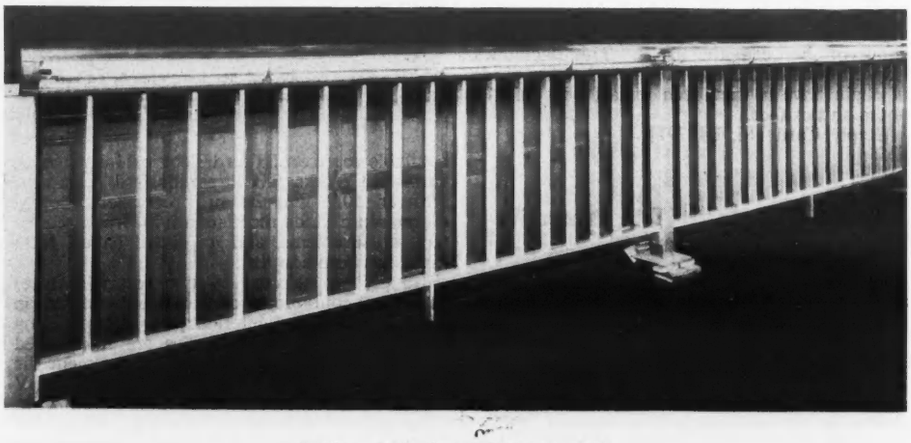
An installation of the Solartron marine radar simulator will soon be made at the Glasgow Technical College, where it is expected to begin radar courses in September. The apparatus at Glasgow will work in conjunction with a Decca radar display. The question of providing an installation which could be switched by the instructor for giving demonstrations on various forms of display has been investigated. While it would be practicable, considerable complexity would be introduced and so equipments are normally supplied for use with a particular radar system.

[Reply Card No. E10801]

### Bridge Handrail in Light Alloy

AN illuminated handrail has been built in aluminium alloy by Saunders-Roe Structures, Ltd., to the order of Hastings of West Africa, Ltd., and to instructions of the Lagos Executive Development Board. The handrail, a section of which we illustrate, is intended for the Onikan Bridge at Lagos and is built of extrusions in aluminium alloy to specification HE30.WP. The bottom rail has a closing strip of Tufnol and the top rail consists of two extrusions, having rubber jointing inserts and a plastic panel, and is fitted to take electric light fittings and a reflector. Oval-shaped hollow extrusions form the intermediate stanchions and fit into slots cut in the top and bottom rails and are locked in position by rods which pass lengthwise through holes drilled, to close limits, in the top and bottom of each stanchion. The main stanchions, which are of hollow square section have steel inserts and are secured to the top rail by four bolts. In each section the lighting assembly consists of two 40W fluorescent tubes, each 8ft long, and the wiring is arranged so that no cutting or jointing is necessary to complete the circuits. The fluorescent tubes are sited to ensure that motorists are not dazzled and the top rail assembly is secured in one unit by locking bolts which require a special key for their release. This prevents any interference with the lighting system.

[Reply Card No. E10802]



**Section of illuminated brid' handrail**

### Symposium on Engine Testing of Crankcase Lubricating Oils

THE Engine Tests of Lubricants Panel of the Institute of Petroleum announces that it is proposed to hold an International Symposium on the Engine Testing of Crankcase Lubricating Oils at Brighton, from May 17 to 19, 1961. The objects of the symposium will be to describe the work so far carried out in this field by the Panel ; to invite other national bodies active in this field to describe their work ; to invite engine manufacturers and users to state their interests and requirements in respect of engine test methods for performance evaluation of lubricating oils ; to invite Government and other national bodies to state their views on evaluation and specification of lubricating oils, and by discussion of these aspects to decide on the action necessary to achieve better co-ordination of all efforts. Short papers are invited and these must be received by the Editor, Institute of Petroleum, not later than September 30.

### Launches and Trial Trips

QUILOA, oil tanker ; built by Scotts' Shipbuilding and Engineering Company, Ltd., for the British India Steam Navigation Company, Ltd.; length between perpendiculars 534ft, breadth moulded 71ft 8in, depth moulded 39ft 6in, summer deadweight 19,045 tons, summer draught 30ft 2in, twenty-seven cargo tanks, two pump rooms ; speed 14½ knots ; two 550kW turbine-driven alternators, one 200kW diesel-driven alternator, one set of double-reduction geared turbines, 8000 service shaft horsepower. Trial, March 25.

FARAHMAND, fire and salvage tug ; built by Ferguson Brothers (Port Glasgow), Ltd., for the B.P. Tanker Company, Ltd., for service at Abadan ; length 120ft, breadth moulded 31ft 6in, depth moulded 14ft 3in, four monitors supplied by Merryweather fire pumps powered by two Rolls-Royce diesel engines ; free running speed 12 knots, static bollard pull 18 tons ; Crossley " C.G.L8/32 " diesel engine, 1500 b.h.p. at 320 r.p.m., Renk reverse-reduction gearbox. Launch, April 12.

# INDUSTRIAL NEWS

### Apprentices Wage Claims

Last week there were discussions between the Confederation of Shipbuilding and Engineering Unions and the Engineering and Allied Employers National Federation and the Shipbuilding Employers Federation respectively concerning claims for increases in apprentices' pay. It will be recalled that recently there were unofficial strikes of apprentices in various parts of the country. At last week's meeting, the engineering employers offered an increased percentage of the adult rate to about 60 per cent of the apprentices employed by federated firms. But they refused an increase to the remaining 40 per cent who, on account of piecework and bonus earnings, are already getting more than the rates offered. These proposals were rejected by the union representatives.

The discussion with the Shipbuilding Employers Federation was adjourned, because the union leaders pointed out that they were seeking an all-round increase. The employers' representatives said that they had understood the claim, as submitted, to be for an increase in the wages of boys, youths and apprentices which would bring them up to a specified percentage of the skilled time rate, according to the age of the apprentices. The fact that the unions were now asking that every apprentice, irrespective of his earnings, must have some increase put the employers in a very difficult position.

### Shipyard Labourers' Wages

Shipyard labourers who are at present paid the national time rate of £7 17s. 6d. on new shipbuilding, or £8 0s. 6d. on ship repairing for a full normal working week of forty-two hours, are to receive a compensatory payment of 1¼d. an hour under an agreement reached on June 16 between the Shipbuilding Employers' Federation and the National Union of General and Municipal Workers and the Transport and General Workers' Union. It is stated that the increase is applicable to those who do not receive any additional wage payment in the form of payment by results, incentive or other form of bonus payment.

Labourers who for a full normal working week of forty-two hours are at present in receipt of a total wage payment of less than £8 3s. 7½d. on new shipbuilding or £8 6s. 7½d. on ship repairing, however that total wage payment is made up, will have their existing total wage payment increased to these amounts by a compensatory payment. The agreement was reached on the understanding that it should not apply to any other class or classes of employee who, for a full normal working week of forty-two hours, were in receipt of a total wage payment in excess of £8 3s. 7½d. a week on new shipbuilding or £8 6s. 7½d. a week on ship repairing, nor should it be used as a means to secure increased payments or the maintenance of existing differentials for any other class or classes of employee.

### Legislation On Restrictive Business Practices

The first two volumes of a series designed to incorporate existing legislation on restrictive business practices in member and associated countries of the Organisation for European Economic Co-operation have been published by the O.E.E.C. European Productivity Agency. These two volumes deal with legislation in Denmark, France, Germany, Ireland, Italy, the Netherlands, Norway, Sweden, the United Kingdom and the United States. A further volume containing information on Austria, Canada, Portugal, the European Economic Community and the European Coal and Steel Community is to appear later in the year.

The O.E.E.C. claims that this is the first time a guide to legislation on restrictive business practices of this nature has been compiled. It is of particular importance at this time in view of the international development now taking place in the field of restrictive business practices and the creation of wider markets. It is hoped that the guide, which will be brought up-to-date from time to time, will be of particular assistance to Government experts responsible for shaping policies in this field ; and to wider circles of industry, trade, professional organisations, economists, lawyers and universities.

### Industrial Power Consumption in Uganda

A survey just completed by the Uganda Electricity Board shows that the majority of coffee curing and hulling factories within the Board's area of supply are now fully electrified. Twenty-two coffee processing factories took power from the public supply for the first time during the 1958–59 season, exactly doubling the number connected for the previous season, so that over three-quarters of Uganda's total coffee crop is now processed at electrified factories. Consumption of electricity by the industry rose to 2,921,000 units, representing an increase of one-third over the 1957–58 figure. Progress has also been made in bringing electricity supplies to more cotton ginneries. Forty-four ginneries used Uganda Electricity Board power to process the 1958–59 crop ; twenty of these ginneries also utilised electricity for other purposes, such as maize and oil-seed milling. By the end of 1959 there were fifty-one ginneries fully electrified and a further fifteen taking a supply of electricity for lighting purposes only. It is stated that the main problem encountered in the Board's electrification programme for the cotton processing industry has been the reluctance of ginners to incur the heavy capital cost involved in making the change-over from their existing prime-movers to electrically-powered machinery.

The fact that electricity has become the major fuel utilised for ginning cotton in certain cotton zones, has given rise to the recommendation made recently by the Lint Cotton Price Committee that the fuel and power component in the formula for fixing the price per bale payable to ginners should be related, where practicable, to the cost of electricity consumed. The proposal extends to those zones where the majority of ginneries are operated on electricity supplied by the Uganda Electricity Board. The committee suggests that the calculation of the cost of electricity per bale would be based upon the actual consumption and charges at efficient ginneries, utilising electricity exclusively for ginning, as supplied by the Uganda Electricity Board in the immediately preceding season. The new formula is recommended initially for the Mbale, South Teso and Teso segregated cotton zones, where the majority of ginneries are already served by electricity. One aspect of electrification which has appealed to proprietors of both cotton and coffee processing factories is that considerable improvements to works lighting can be effected, thus enhancing not only efficiency, but also the safety and welfare of employees.

### International Co-operation in Fire Research

There has recently been held in London a meeting of scientists from fire research laboratories all over the world to exchange information on their work and to discuss future co-operative research projects. Two groups took part in these meetings, one under the aegis of the Conseil International du Bâtiment and the other under that of the European Productivity Agency. The United Kingdom is represented in both these groups by the Joint Fire Research Organisation of the Department of Scientific and Industrial Research and the Fire Offices' Committee, a visit to whose laboratories at Boreham Wood took place during the meetings.

Agreement was reached on a joint programme of research in which various countries, including the United Kingdom, are to take part. The programme is designed to provide information on the effect of the size and shape of buildings on the growth of fire. As part of the programme, the effect of wind on fire conditions will be studied in the new wind tunnel at the Joint Fire Research Organisation at Boreham Wood. Preliminary research at the station has indicated that the results of model experiments can be applied to full-scale fires. It is now intended to extend the scope of the work using models to study the mechanism of fire extinction.

### Colonial Development

The Colonial Development Corporation's annual report for 1959, which has just been published, shows that the Corporation now has eighty-eight development projects in twenty-six colonies and Commonwealth countries. The total capital approved for them is £96,000,000 but new approvals since the end of 1959, together with estimated further investment to complete existing projects, bring the Corporation's total commitments to date to nearly £115 million. The report says that fifteen new projects were undertaken during the year, the capital approved for them, and additional capital for existing projects, being £17,230,000 compared with £3,000,000 in 1958. More projects have passed the development stages and are coming into full production. Colonial products from direct projects and associated companies during 1959 reached the value of about £18,000,000, much of it contributing to the export trade of various colonies.

The report remarks that the correct adjustment of the relationship between highly industrialised countries and the under-developed countries is one of the greatest problems facing the world today. Even when money and technical aid are available, the capacity to put them to the best use is often lacking. In those under-developed territories for which Britain is responsible, the Corporation, it is claimed, is in a unique position to assist in finding a solution, as it has now built up an organisation staffed by experienced people and designed for this very purpose.

# PERSONAL AND BUSINESS

## Appointments

MR. OSCAR M. MANSAGER has been appointed deputy chairman of Hoover, Ltd.

MR. BERNARD WRIGHT of John Thompson Instrument Company, Ltd., has been promoted to the position of sales manager.

MR. W. E. A. REDFEARN has resigned as chairman of the Alloy Steels Association and has been succeeded by Mr. R. Bavister.

MR. H. V. BLAKE has been appointed commercial manager of Glass Yarns and Deeside Fabrics, Ltd., a member of the Microcell Group.

MR. J. C. NUTTER and MR. R. Y. PARRY have joined the board of Isotope Developments, Ltd., a member of the Elliott-Automation Group.

THE CENTRAL ELECTRICITY GENERATING BOARD has announced the appointment of Mr. Philip Paul as publicity officer in its public relations branch.

LONDON TRANSPORT has announced that Mr. E. J. Pickett has been appointed principal executive assistant in the office of the new works engineer.

SCOTTISH PLANT SALES, Ltd., the sole dealer for Case tractors in Scotland, has announced the appointment as senior representative of Mr. David Rollo.

MR. J. E. BISHOP has been appointed general sales manager of the Pulsometer Engineering Company, Ltd., and Joseph Evans and Sons (Wolverhampton), Ltd.

MR. BRIAN H. TURPIN, managing director of QVF, Ltd., and of Quickfit and Quartz, Ltd., has been elected to the Council of the British Chemical Plant Manufacturers' Association.

MR. DAVID C. HANEY has been appointed managing director of the International Harvester Company of Great Britain, Ltd., in succession to Mr. O. G. Voss who has returned to the United States.

THE GENERAL ELECTRIC COMPANY, Ltd., announces that Mr. T. N. Kelsey has been appointed deputy general manager to Mr. J. J. Gracie, director of the company, and general manager of Witton Engineering Works.

MR. D. G. HAWKINS, A.M.I.E.E., has been appointed to be responsible for the computing services of the Central Electricity Generating Board. He will be located at Bankside House, Sumner Street, London, S.E.1.

MACGREGOR AND CO. (CARGO HANDLING), Ltd., announces that Mr. Raymond Nagel of MacGregor-Comarain, Paris, and Mr. John Johnson of MacGregor and Co. (Naval Architects), Ltd., have been appointed additional directors.

MR. B. S. FREELAND has been transferred to the staff of the chief engineer (sales) of Tufnol, Ltd., for special duties in the market research unit. He has been succeeded as London area branch manager by his former deputy, Mr. F. J. Griggs.

THOS. W. WARD, Ltd., announces that Mr. W. S. Cliffe is to retire as manager of the machinery department (southern area) on June 30. He will continue to serve in an advisory capacity until December 31. He will be succeeded in his appointment by Mr. C. R. Harkcom.

RALEIGH INDUSTRIES, Ltd., announces that following the declaration by Tube Investments, Ltd., of its offer to the ordinary shareholders of Raleigh Industries, Ltd., as unconditional, Major-General Sir Francis de Guingand and Mr. T. J. Boulstridge have been appointed to the board of Raleigh Industries, Ltd.

KESTNER EVAPORATOR AND ENGINEERING COMPANY, Ltd., states that following the death of Mr. W. Dunbar Ferns, who had represented the Kestner group in Scotland for the last fifteen years, his son, Mr. A. W. Dunbar Ferns has now joined the company as technical sales engineer and will represent the Kestner interests in Scotland.

ACHESON DISPERSED PIGMENTS COMPANY announces the following appointments and promotions: Mr. B. R. Corry has been transferred from another unit of the Acheson Organisation and promoted to works chemist; Mr. T. H. Stothard has been appointed works manager; Mr. K. Harwood has been promoted to the new position of production supervisor.

HEAD WRIGHTSON AND CO., Ltd., announces the following appointments among its subsidiary companies: Mr. J. G. Allen as managing director of Head Wrightson Steel Foundries, Ltd.; Mr. G. Jones to be managing director of Head Wrightson Stampings, Ltd.; Mr. W. H. Mather as managing director and Mr. G. Gowthorp as commercial director of the Head Wrightson Machine Company, Ltd.; Mr. T. H. Stayman as managing director of Head Wrightson Iron and Steel Works Engineering, Ltd.

APPLEBY-FRODINGHAM STEEL COMPANY, a branch of The United Steel Companies, Ltd., announces that with effect from July 1, Mr. R. Wogin, at present manager of the Appleby melting shop, will become assistant works manager (steel). Mr. R. Johnson has been appointed melting shops manager, responsible for both the Appleby and Frodingham melting shops, together with the basic slag plant and the refractories section. Mr. A. F. Jessop has been appointed manager of the Appleby melting shop and Mr. W. L. Willsher becomes manager of the Frodingham melting shop.

## Business Announcements

C. E. SLEEPER, Ltd., has moved to larger and more modern factory premises at Ponsford Works, Minehead, Somerset.

OPTOSHIELD, Ltd., 146, Clerkenwell Road, London, E.C.1, has been appointed sole distributor in Great Britain of AMPCO spark-resistant tools.

RICHARD SUTCLIFFE, Ltd., Horbury, Wakefield, Yorkshire, has announced the formation of a subsidiary company, Sutcliffe Plant Hire, Ltd., 14a, Bond Street, Wakefield (telephone, Wakefield 6433).

VENESTA FOILS, Ltd., states that its sales, market development and administrative offices are to move to new premises at Thorn House, Upper St. Martin's Lane, London, W.C.2., (telephone, Temple Bar 6655) on July 11.

HIRD-BROWN, Ltd., 244, Marsland Road, Sale, Cheshire, has been formed to design and manufacture photo-electric controls. The company has absorbed the entire activities of Paton Brothers Engineering Services, formerly carried out at the same address and at 15, St. James Row, Sheffield. The joint managing directors are Mr. T. Bryan Hird and Mr. Roy Brown.

THE TELEGRAPH CONDENSER COMPANY, Ltd., of the United Kingdom, and SPRAGUE ELECTRIC COMPANY, of the U.S.A., announce that they have come to an arrangement whereby T.C.C. acquire the right to all Sprague United Kingdom patents and applications, together with the technical and engineering information necessary to exploit them, and Sprague will make available to T.C.C. all its present research and technical information and engineering knowledge and for the next twenty-one years the two companies will exchange research, development and manufacturing knowledge, extending beyond the field of capacitors and embracing all the products of the two companies.

THE BIRMINGHAM SMALL ARMS COMPANY, Ltd., announces that it is intended to make all the companies of the B.S.A. Group function autonomously with their own boards of directors and with the deputy chairman and chief executive, Mr. Eric Turner, having a seat on the majority of these. In implementing this policy, the following additional directorships have been announced: B.S.A. Motor Cycles, Ltd., Messrs. Eric Turner, W. L. Rawson, J. W. Binsted, A. H. Jones. Triumph Engineering Company, Ltd., Mr. Eric Turner. Ariel Motors, Ltd., Messrs. Eric Turner, Edward Turner, R. J. Fearon. Carbodies, Ltd., Messrs. Eric Turner, J. E. Rowe, C. W. F. Parker. Idoson Motor Cylinder Company, Ltd., Messrs. Eric Turner, J. E. Rowe, R. F. K. Belchem, R. J. Fearon. Birtley Engineering, Ltd., Messrs. Eric Turner, F. Jordison, A. E. B. Smith. B.S.A. Metal Powders, Ltd., Mr. J. W. Binsted. Metal and Plastic Components, Ltd., Mr. J. W. Binsted.

## Contracts

BROOK MARINE, Ltd., has received the following orders: a trawler of 127ft length overall, 25ft beam and 12ft 6in depth, from the Stirling Fishing Company Ltd.; a trawler of 116ft 10in length overall, 23ft beam and 11ft depth, from Talisman Trawlers, Ltd.; and two trawlers of 108ft 9in length overall, 22ft beam and 10ft 6in depth, from W. H. Podd, Ltd.

TARMAC CIVIL ENGINEERING, Ltd., has been awarded the contract for a new bridge at Maentwrog by the Merionethshire County Council. The work consists of a three span bridge, on two mass concrete abutments and two river piers. The spans consist of a reinforced concrete deck on concrete-cased "Universal" steel beams. The value of this contract is £90,173 and it will take about eight months to complete.

COURTAULDS, Ltd., and LUNA, Ltd., a wholly-owned subsidiary of Courtaulds, have entered into a contract with "Acetilen" of Skopje, Invest-Import, Belgrade, and "Vardar" Export-Import, Skopje, whereby Luna will supply plant and machinery for a factory in Yugoslavia to produce acrylic fibre. The value of the contract exceeds £2,000,000. Deliveries of plant will begin next year and the factory will be in operation in 1962.

THE GOOLE SHIPBUILDING AND REPAIRING COMPANY, Ltd., announces that it has received from H. L. Taylor, Ltd., an order for two trawlers, each of 127ft length overall, 25ft beam and 12ft 3in depth, and propelled by a Mirrlees "KSCDM 6" diesel engine of 700 s.h.p. at 234 r.p.m. The company has also received an order from Consolidated Fisheries, Ltd., for three trawlers, each measuring 137ft 3in by 28ft by 14ft 3in and powered by a Mirrlees "KSSDM 8" diesel engine of 1120 b.h.p. at 270 r.p.m.

RICHARD COSTAIN (CIVIL ENGINEERING), Ltd. has been awarded a contract to construct the £500,000 Lamaload dam for the Macclesfield Corporation. The dam, which will be a mass concrete buttress type, will be 600ft long, 160ft high and 150ft thick at its base, tapering at the top to 7ft. Work is expected to begin in July and it is anticipated that water will be drawn from the reservoir in 1963. Site of the reservoir is in the valley of the River Dean, 3¼ miles to the north-east of Macclesfield; it will have a catchment area of 1000 acres and a holding capacity of 430 million gallons. The top water surface, 45 acres in extent, will be 1010ft above sea level. The consulting engineers are Herbert Lapworth and Partners.

HOLLAND & HANNEN AND CUBITTS (TRINIDAD), Ltd., is to build the main block of the new Technical Institute in Port of Spain, costing 1,174,846 W.I. dollars (£244,759), for the Government of Trinidad and Tobago. Work has started on the contract and will take fourteen months to complete. The new "L"-shaped building will be in Wrightson Road on the west side of the Caribbean Medical Centre, and will house class rooms, practice rooms and an administration area. Part of the building will be two storeys and part three storeys high, and there will be a 62ft high clock tower. It will cover an area of 534ft by 34ft fronting Wrightson Road with a 336ft by 34ft return along the eastern boundary of the site. With a reinforced concrete frame the building will have hollow clay and concrete block panel walls and partitions and asphalt covered flat roofs. Quantity surveyors are C. T. R. Kelly and Partners, 8, Manchester Square, London, W.1. and the main contractor is Holland & Hannen and Cubitts (Trinidad), Ltd., 1, Queen Anne's Gate, London, S.W.1.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd. (HEAVY PLANT DIVISION), is to supply two 40MVA synchronous condensers (the largest ever ordered by the Central Electricity Generating Board) for the Board's substation at Iver, Bucks. The order includes auto-transformers for starting, automatic voltage regulators of the magnetic-amplifier type, and push-button starting equipment. The condensers, which will be connected to the supergrid through the tertiary winding of a 275/66/11kV transformer, are designed to work at their normal rating over a range of 11kV to 13·2kV. They will run in water-cooled bearings at 1000 r.p.m. Water-cooled air-coolers and an air-blast water-cooler will be used for ventilation. Since each machine will be totally enclosed, it will be suitable for outdoor use, and although the total weight will be approximately 110 tons, erection and maintenance can be carried out without a heavy crane. These condensers will enable leading or lagging reactive power to be fed into the supergrid system as required, and will thus enable the lines to be operated more efficiently over the range of loading conditions.

# CONTINENTAL AFFAIRS

*by Our Continental Editor*

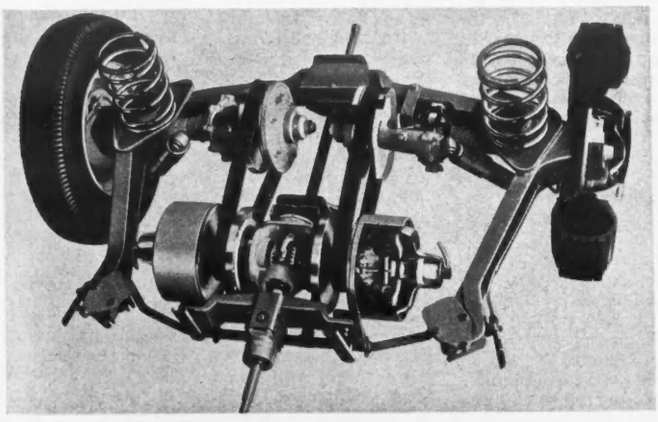
## Motor Vehicle Production in Holland

*The production of motor vehicles in Holland is concentrated at the Van Doorne's Automobielfabriek (D.A.F.) in Eindhoven. During the past ten years this has become an important manufacturing centre, and is now producing eighty-five cars and thirty-two commercial vehicles per day.*

THE choice of The Hague as the location of the recently-held Eighth International Automobile Technical Congress has given added emphasis to automobile engineering developments in Holland and, in particular, to the Dutch motor vehicle production concentrated at the Van Doorne's Automobielfabriek N.V., in Eindhoven. The latter has grown from a small workshop with a floor area of only 160 square feet in 1928 to a well-equipped modern factory having a total roofed floor area of 1,400,000 square feet and producing more than 100 vehicles per day. The expansion of the manufacturing facilities of the Van Doorne company, or D.A.F., took place largely during the past decade, for it was only in 1950 that it started quantity production of commercial and military vehicles. Prior to that date it had mainly produced trailers, but it was also responsible for some interesting experimental vehicles, including a six-wheeled armoured car and a four-wheeled amphibious vehicle built in 1938 and 1939 respectively. Since 1958, the company has added a light car to its range of products, the D.A.F. 600. This 1390 lb four-seater was conceived in 1954 and is powered by a D.A.F.-designed two-cylinder air-cooled, 600 c.c. engine driving the rear wheels through a " Variomatic " automatic transmission, which embodies a veé-belt in the drive to each wheel and a pair of pulleys whose effective diameter varies with engine speed and manifold vacuum. The introduction of this transmission in the D.A.F. 600 was preceded by three years' development testing and the life of the vee-belts, which are potentially its weakest member, is now stated to be between about 25,000 and 38,000 miles. The latest D.A.F. development is an eight-wheeled armoured personnel carrier, the " YP-408," a vehicle based on the six-wheel drive " YA-328 " artillery tractor but with an additional, unpowered pair of wheels as well as an armoured body. Sufficient traction is said to be obtained with the six driven wheels, but the additional pair helps in obstacle crossing and to reduce ground pressure in cross country operation.

The general layout of the D.A.F. factory is indicated by the aerial photograph reproduced on this page. There are four main manufacturing departments : general machine shop, engine machining and assembly, press shop and the final assembly department. Of the four, the first two are located to the left of the central office block and the last two to the right. Alongside the press and final assembly buildings and clearly visible in the right foreground of the photograph there is a paved test track which encircles a rough ground used for testing or demonstrating cross-country vehicles. The factory buildings, as well as the attractive and very well appointed office block, are spacious, and throughout attention has been paid to the welfare of the employees. At the beginning of this month the total number of employees had exceeded 5000. This included about 200 pupils of the trade which offers a two-year technical training course leading to the metal worker's diploma or six months' technical training for specific factory jobs.

Each of the four main manufacturing departments is divided into passenger car and commercial vehicle sections. In the engine department the units produced are the D.A.F. 600 c.c. car petrol engine and the Leyland 0.350 six-cylinder diesel engine manufactured under licence, and the equipment includes a number of transfer machines, the largest being a Hüller model used to machine car engine crankcases. The cost of the latter machine is approximately £150,000 and the total value of the machines in the general machining and engine departments is estimated at £6,000,000. In contrast to the engine castings, which are bought out, pressings for the car bodies, as well as for commercial vehicles, are made in the factory using a number of Hydraulic Press Manufacturing presses of up to 1200 tons and smaller Fritz Müller presses. The car body is of integral construction and its assembly involves 5000 spot welds. In addition



" Variomatic " transmission, partly sectioned

" YP-408 " armoured personnel carrier

## CONTINENTAL AFFAIRS *(Continued)*

**Hüller transfer machine set up for machining car engine crankshafts**

to the pressing and welding, all painting and trim are also done in the factory.

Current car production is at the rate of eighty-five cars per day, but it has been rising steadily, and the existing manufacturing facilities have been planned for an output of 200 cars per day. Already more than 10,000 D.A.F. 600 cars have been produced. Commercial vehicle production has also risen and is at the rate of four vehicles an hour, or thirty-two per day.

# Fault Current Protection

INCREASED use of electric tools and equipment and more widespread installation of floors which are good conductors of electricity give rise to an increased risk of accidents. Protection by means of fuses or short-circuit breakers in combination with wall conductors and earthing is basically imperfect because it involves an excess current device as a safeguard against high contact voltages. Such devices operate on the principle of allowing fault currents to develop into short-circuit currents, which then operate a cut-out or a fuse, and it is frequently necessary to incorporate a substantial delay period during which these currents have to be withstood. The protection afforded to personnel or animals is therefore inadequate. Moreover, through an oversight, wall conductors may be wrongly connected, or they may be interrupted (e.g. owing to loose terminals), so that their presence may actually give rise to danger.

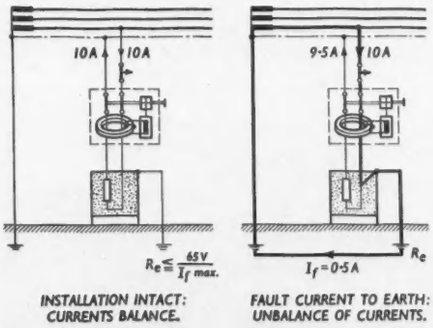



**Fig. 1—Action of fault current breaker; when the fault current reaches a predetermined value, the breaker cuts out**

Protective earthing, in accordance with the latest German regulations, demands such a low resistance in the earth circuit as cannot be achieved economically by means of a single earth connection. For instance, for a nominal current of 10A, the maximum resistance to earth is specified as 1·8 Ω. Such values can in practice only be achieved by making the earth connections to an extensive grid of buried water pipes. Even if these are available, very often their efficacy is cancelled out by the presence of plastic fittings or of sections of plastic pipe. The resistance to earth is also much influenced by temperature and moisture. In unfavourable circumstances, a high earth resistance may cause a delay of several seconds before the fuse blows, which from the safety angle is very objectionable.

A better means of protection is afforded by fault voltage breakers but these can also become operative through an accidental shorting of the voltage coil, or errors in wiring.

Siemens-Schuckertwerke A. G., Berlin—Erlangen, has therefore introduced a fault current breaker which does not lay itself open to the disadvantages mentioned and is claimed to present several distinct advantages of its own. The basic principle, illustrated by Fig. 1, is the fact that in a balanced multiphase system the instantaneous sum of the currents is zero. If all conductors (including the star point connection, if any) are taken through the core of a ring transformer, there will be no voltage in the secondary winding as long as the system remains in balance. If the balance is disturbed, for instance, by a fault current developing, then a secondary voltage is induced which can be employed to bring out the breaker.

Although it seemed attractive to make the cut-out respond to the actual fault current passing through a person (which is of the order of 100mA), this idea had to be dropped as frequently harmless fault currents exist which add up to a total of this order, which, when passing through the equipment, would cause an unwarranted action of the breaker.

On the other hand, the response current must not exceed a value given by the quotient of the contact voltage divided by the resistance to earth. German regulations limit the maximum admissible contact voltage to 65V in the case of persons an 24V in that of animals. In the latter case, therefore, if the cut-out fault current is 3A, and 8Ω earth resistance is necessary. This can seldom be reliably achieved by means of a single earth point.

A compromise has therefore to be struck by choosing a cut-out current high enough to be well above any admissible fault currents but not so high as to require an excessively low earth resistance. The maker selected a cut-out current of 0·5A, for which an earth resistance of 130Ω is normally admissible. It is, of course, in any case desirable to keep the cut-out current as low as possible in order to limit the risk of fire from arcing if this should occur. If considerations of keeping equipment going for as long as possible do not operate, then it would even be possible to increase the sensitivity of the device so as to make the cut-out operate before the insulation breaks down completely.

The working principle of the mechanism is shown in Fig. 2. All conductors are threaded through the annular core of the current transformer, the secondary of which is connected to an electromagnet which holds in the armature of the spring-loaded cut-out mechanism. A push button can be used for artificially introducing a "fault current" in order to test the breaker. Fig. 3 shows the magnetic circuit, with the flux distribution during normal operation, and also during the occurrence of a fault.

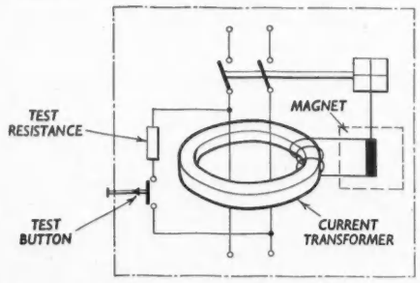
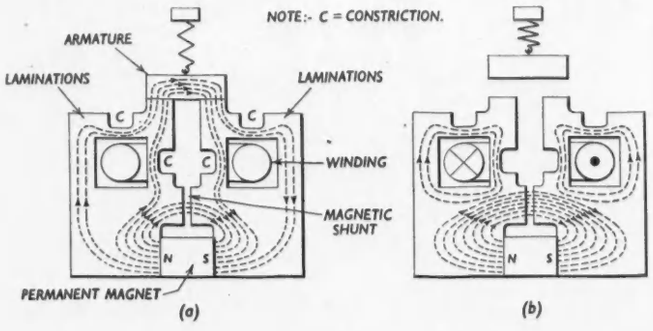



**Fig. 2—Diagrammatic view of breaker**

The core incorporates a permanent magnet in a stack of soft laminations. At the constrictions the iron is nearly saturated, while at another point the laminations approach so as to form a magnetic shunt. With a net current flowing in the winding,

(*a*) Normal operation
(*b*) Operation with fault current

**Fig. 3—Flux distribution in magnet**



the permanent magnetism is forced to pass entirely through the shunt, and the armature is released. This in turn causes the breaker to come out under spring pressure.

With the employment of high quality magnetic material, the energy required to release the breaker is very small. No mains voltage at all is required to operate the mechanism, a fact which could be of importance if all fuses had blown and a dangerous voltage were introduced over the common conductor.

While the response current is held to the practicable value of 0·5A, the maximum current which the breaker may have to interrupt can be very substantial. For that reason, the design breaking capacity is 1500A. Reliability is stated to have been shown by tests when the breaker was still fully operational after 10,000 breaks at nominal loads. The breaker operates in less than 0·1 second, and is claimed to be entirely proof against welding together of the contacts.

The fault current breaker can be installed in addition to any existing protective devices without the need to alter the circuit. It is particularly applicable where the use of fault voltage breakers is difficult, e.g. in connection with immersion heaters. Under the dangerous conditions often found on building sites the breaker, it is claimed, can be advantageously installed either separately for each item of equipment, or one for each group or possibly even for the whole distribution board.

## I.A.E.A. Conference

Five large scientific conferences and seventeen symposia have been scheduled by the International Atomic Energy Agency, Vienna, to take place between July 1, 1960, and the end of 1961. The schedule, which in some parts is still provisional, particularly as to the exact places and dates in 1961, comprises the following events: "Effects of Ionising Radiation on Seeds and Their Significance on Crop Improvement" (Symposium, Karlsruhe, August 8–12); "Medium and Small Power Reactors" (Conference, Vienna, September 5–9); "Use of Radioisotopes in Physical Sciences and Industry" (Conference, Copenhagen, September 6–17); "Inelastic Scattering of Neutrons in Solids and Liquids" (Symposium, Vienna, October 11–14); "Neutron Pile Research" (Symposium, Vienna, October 17–21); "Diagnosis and Treatment of Acute Radiation Injury" (Symposium, Geneva, October 17–22); "Chemical Effects of Nuclear Transformation" (Symposium, Prague, October 24–27); "Education and Nuclear Energy" (Regional Symposium, Argentina, November 7–11); "Nuclear Ship Propulsion with Special Reference to Safety" (Symposium, Italy, November 14–18); "Pest Control by Radiation" (Symposium, India, December 5–9); and "Use of Radioisotopes in the Study of Endemic and Tropical Diseases" (Regional Symposium, Bangkok, Thailand, December 12–16). Next year, meetings will include: "Detection and Use of Tritium in the Physical and Biological Sciences" (Symposium, Vienna, January); "Nuclear Electronics" (Conference, April–May); "Controlled Thermonuclear Fusion" (Conference, May–June); "Whole Body Counting" (Symposium, May); "Pre-Treatment of High Level Radioactive Wastes" (Symposium, May); "Radioisotopes in the Biological Sciences" (Conference, July–September); "Effects of Ionising Radiation at the Molecular Level" (Symposium, June); "Fast and Intermediate Reactors" (Symposium, August); "Power Reactor Experiments and Tests" (Symposium, October); and at some date in the autumn, the symposia "Radiation Damage in Solids and Reactor Materials" and "Programming of Research Reactors."

## Sea Disposal of Radioactive Waste

An eleven-man international panel has been studying the question of disposal of radioactive wastes at sea and has now submitted its report to the Director General of the International Atomic Energy Agency. The reports have pointed out that the first principle must be the safeguard of man against damage from radiation and that only such waste disposal methods should be considered as do not involve any risk that is unacceptable either to the individual or the population at large. In assessing the safety of proposed disposal operations, the most recent recommendations of the International Commission of Radiological Protection should be used as a guide.

One of the principal conclusions of the report is that the release of highly radioactive waste cannot at present be recommended as an operational practice, but that the sea disposal of wastes of low and intermediate activity may be safe under controlled and specified conditions.

The panel has recommended that all radioactive wastes disposed of into the sea, with the exception of those incidental to the operation of nuclear-powered ships, should be released into designated disposal sites in conformity with conditions specified for each particular site.

Wastes from nuclear ships should be released in such a way as not to limit the harvest of marine products.

Each disposal site should be designated by responsible national or international authority, which should also set out the conditions of disposal for the site. It should also monitor the area to verify that safe conditions are maintained and collect disposal records that would adequately indicate the state of the site. All such authorities should supply information necessary to maintain an adequate register of waste disposals into the sea. This register should be kept by the International Atomic Energy Agency which should receive notice of the licensing requirements of all sea disposal areas, annual reports on the state of these sites, and the monitoring programme and all relevant scientific findings. The Agency should provide for any necessary standardisation of monitoring techniques.

As regards the disposal of wastes from nuclear ships, the panel has stated that a record should be maintained on every ship for inspection by port authorities, and all disposals in harbours and national waters should be in conformity with conditions laid down by the local authority. Disposal in international waters should be in conformity with conditions specified in the licensing of the vessel or by the appropriate international authority.

Finally, the panel has recommended that I.A.E.A., in collaboration with other international organisations concerned, should review these problems at appropriate intervals.

## High-Power Xenon Lamp

Last month, a high-power, single-source lamp standard was put into service in front of the "Am Zoo" railway station, Berlin. This equipment, supplied by Siemens-Schuckertwerke, Berlin-Erlangen, is claimed to be the most powerful of its kind. It contains a single Xenon lamp of 65kW, which emits a light flux of 2,000,000 lumen, equivalent to about 4600 commercial 40W incandescent lamps. The light, however, approaches daylight in quality, so that all objects appear in their natural colours.

The lamp fitting, which weighs approximately 1·1 tonne, is mounted on a 23m-high mast of octagonal section. The housing measures 4·5m in length and 1·6m in width. Above the tubular lamp, highly polished aluminium reflectors are fitted, while underneath removable transverse segments prevent glare. At the ends of the fitting are the two starters which provide the necessary high tension of 90kV for igniting the lamp. Because of the design of the housing, which promotes convection, no special ventilation is required. Maintenance is carried out from a special platform which can be fixed to the arms which hold the fitting.

The lamp receives its current from the local 380V mains and is in series with a choke which is separately housed together with the switching equipment. By means of audio-frequency pulses the lamp is switched on in conjunction with the rest of the street lighting. The ordinary lighting in the surrounding area, however, remains extinguished while the high-power lamp is in use. Late in the evenings when major traffic has ceased, a time switch cuts out the high-power lamp and switches on the ordinary street lamps.

In 1958, a high-power street lamp giving 1·7 million lumen was installed on the Stachus square in Munich and a similar lamp was used at Thessalonika one year later to light an exhibition. These standards were, however, each fitted with three 20kW Xenon lamps as well as six high-pressure fluorescent lamps of 400W. Their power was 1·7 million lumens.

## Safety Device for Gas Cookers

The two dangers connected with the use of domestic gas-burning appliances are carbon monoxide poisoning and explosion. While coal gas poisoning could be prevented by removal of the carbon monoxide, as has been done at Basle, this is an expensive procedure and, above all, does not overcome the second danger of an explosive mixture arising. In the case of domestic workers, such an escape can easily occur if a flame becomes accidentally extinguished by liquid boiling over, or if, as sometimes happens, an absent-minded housewife turns on the gas but forgets to light it. In order to make domestic cookers safer, German legislation now requires that all new cookers supplied after July 1, must be equipped with means preventing an escape of unburnt gas.

One device for preventing gas from escaping incorporates a valve fitted with a bimetal strip normally heated by the flame. If the flame goes out, the valve shuts down.

Another device, manufactured by the firm of Junkers and Co., Wernau (Neckar), operates on the basis of thermo-electricity. A thermo-electric element heated by the flame develops a voltage of about 30mV. It supplies the current for a retaining magnet holding open a valve in the supply pipe. Failure of the flame cuts out the electro-magnet and the valve is shut by spring pressure. In order to light the gas, the valve must be held open by a press button until the thermo-element develops sufficient electromotive force.

## Frankfurt Batelle Institute

The sixth Annual Report of the Batelle Institut e.V., Frankfurt/Main, shows that during 1959 the number of employees has again increased, from 404 to 461, including 305 scientists and technicians. In order to start up a mechanical engineering section a suitable building was constructed, and a building to house additional biological laboratories was begun early this year. The Institute carries out contract research in physics, electrical technology and electronics (which have now been grouped together as "Space Technology"), chemistry, plastics and fibres, bio-chemistry, mechanical engineering, metallurgy, technology of silicates, organisation and market research, and sub-sections of these fields. Among a wide variety of research problems on which work was carried out last year, mention may be made of the development of novel optical signal transducers, theoretical and experimental work on wave propagation in plasmas, new electrical winding methods and magnetic circuits, chemical separation techniques, identification of alkalis in ceramics by emission spectroscopy, tracer chemistry, manufacture and application of plastics, development of pharmaceuticals, cosmetics, insecticides and disinfectants, new processes for the biological use of waste products and water purification, permanent magnets, powder metallurgy, wear of metal surfaces, improvement of ceramic materials of all kinds and development of production methods.

## Karl Fredrik Göransson

We learn with regret of the death, on June 13, of Karl Fredrik Göransson, chairman of the Board of Directors of Sandvik Steel Works for the period 1939-59. Mr. Göransson was the grandson, and only surviving direct male descendant, of G. F. Göransson, the first man to exploit successfully on a commercial basis the Bessemer process of steelmaking. Mr. Göransson was director of Jernkontoret (Swedish Ironmasters' Association), 1928-49; chairman of the Swedish Federation of Industries, 1939-42; President of the Swedish Academy of Science, 1948-49, and a Member of the Scientific Society of Upsala.

# THE AMERICAN SCENE

*by Our American Editor*

## American Nuclear Congress and Atomic Exposition

No. IV—(*Concluded from page* 1032, *June* 17)

*The* 1960 *Nuclear Congress and the sixth International Atomic Exposition were held at the New York Coliseum from April* 4 *to* 7 *; the congress was organised under the sponsorship of the Engineers' Joint Council in co-operation with twenty-eight American and Canadian engineering institutions. The exhibition was sponsored by the Atomic Industrial Forum and presented a comprehensive picture of the current state of development in the application of atomic energy in American industry.*

### Brush Beryllium Company

VARIOUS examples of fabricated beryllium components for the nuclear industry were displayed by the Brush Beryllium Company, of Cleveland, Ohio, including reflector parts for the BR-2 reactor now operating in Belgium. This reactor was designed co-operatively by the Nuclear Development Corporation of America and the Centre d'Etudes de l'Energie Nucleaire for the nuclear research centre at Mol. The reactor was designed for a high degree of flexibility to accommodate capsule, loop and rabbit experiments in its core and beam tubes outside the reactor vessel. It is light water cooled, and beryllium moderated and reflected. Unlike most other research reactors, the beryllium is used in a matrix assembly which also acts as a support for the fuel elements, control rods and in-pile experiments.

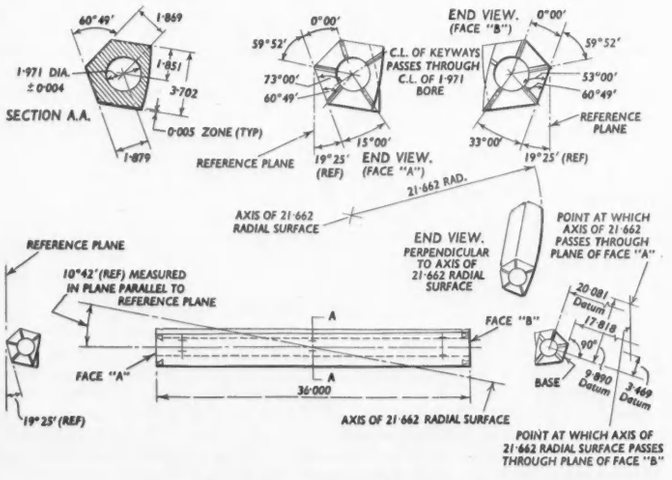
In order to produce high neutron fluxes at moderate power output a compact core was required, but for experimental convenience each core position has a separate seal in the reactor cover to permit changing experiments and fuel elements without disturbing experimental or operating equipment already in the reactor. This was accomplished by twisting the reactor matrix parts to form a hyperboloid so that the core lattice positions are close together at the centre plane yet widely spaced at the reactor covers.

The reactor complex includes sixty-four "holes" 3·3in diameter for experiments, fuel elements and control rods used interchangeably. Thirteen of these holes can be used for through experimental loops. In addition, it contains five "holes" 2in in diameter available for rabbits and small experiments. At a reactor power level of 50MW(t), the maximum thermal neutron flux in the core is $6{\cdot}2\times10^{14}$n per square centimetre per second, the maximum epithermal core flux is $2{\cdot}4\times10^{15}$n per square centimetre per second, and the maximum epithermal neutron flux in the reflector region is $1{\cdot}7\times10^{15}$n per square centimetre per second. The high gamma heating flux requires that the beryllium matrix be subdivided to minimise differential thermal expansion and thermal gradient stresses. The resulting structure is a number of hollow hexagonal prisms modified as required around the large holes and the outer core perimeter to accommodate the twist in the entire assembly.

When viewed from the top, the assembly looks like a honeycomb 43·3in in diameter and 36in long. Each hexagonal cell of the honeycomb is a beryllium bar, but the true hexagonal shape of each bar is complicated by a skew through the entire assembly which gives each piece a distortion that changes true hexagons into slightly irregular versions of hexagons. Thus instead of true 60 deg. angles, each hexagonal shape has angles varying from 0 deg.–23 min. over to 0 deg.–11 min. under a true 60 deg. angle. In addition, fifty-eight pieces are actually partial sections of hexagons ; those around the outer perimeter having convex radii on one face, and those around the five 8in diameter holes having concave radii on one face. Eight pieces are placed in such a manner as to have both convex and concave radii. Each piece in the assembly has at least one hole varying from $\frac{1}{2}$in to 3·3in in diameter completely through the 36in length. The tolerances and surface finish necessarily are extremely close since all pieces in the assembly must fit without interference or excessive play.

Since beryllium is considered a toxic material if inhaled into the lungs, special precautions are observed in machining operations. Toxicity is not a problem with solid metal pieces in use, but becomes a potential health hazard from airborne dust particles such as might be produced by grinding operations or oxidation at temperatures above 1500 deg. Fah. as the oxide particles flake off. The toxicity problems of beryllium have been overcome in the machining operations at the Brush Beryllium Company by safeguards, including continuous air sampling, to ensure that the dust count remains at a level well below that allowed. To control the dust level all machines are equipped with evacuating systems which suck all chips away from the cutting tool and deposit them in air-tight containers. To ensure that no contamination is carried outside the plant, all manufacturing employees are supplied with a complete change of clothing, including underwear, socks and shoes, upon their arrival at the plant every morning. They must take a shower before changing back into their own street clothing at the end of the day.

Nearly all machining operations at the firm's works are performed dry, the only exceptions being gun drilling, trepanning, sawing and grinding. Grinding is kept to an absolute minimum and is used only if necessary, because the fine particles released by grinding present a problem in atmospheric control. The sludge from the grinders is contaminated in such a way that it is economically inadvisable to recover the beryllium for recycling. Fortunately, the




All angular and linear dimensions shown are basic zero tolerance dimensions, referring to a theoretical axis described by the centre of the 1·971 bore in faces *A* and *B*. The piece is acceptable only if the longitudinal surfaces are within the defined zone.

**Fig. 20—Hexagonal honeycomb cells of beryllium for the core of the "BR-2" research reactor in Belgium**

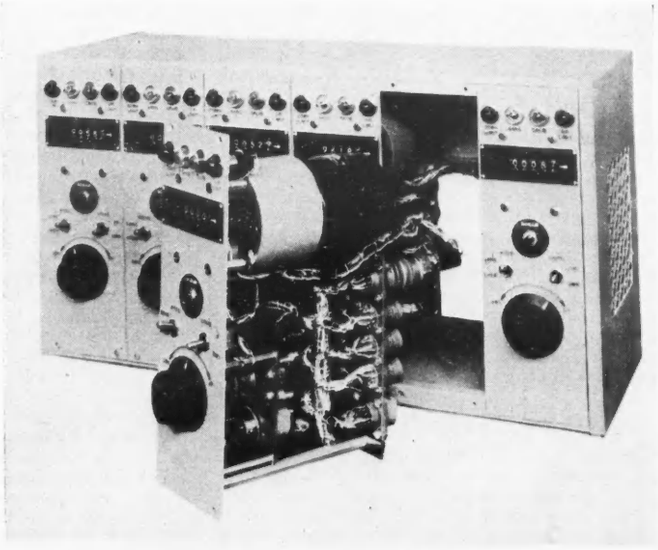


**Fig. 21—Control panel of "Leartron" rod positioning system for nuclear reactors, with power supply and amplifier units**

free cutting characteristics of beryllium are such that extremely good surface finishes are obtained without grinding. It is not unusual to obtain finishes of 32 micro-inches R.M.S. or better in conventional milling operations. Tolerances, which in more conventional materials would be held by grinding, are achieved by normal machining operations. Although beryllium is characterised by free chip formation it is abrasive in its action on tools and tool life is relatively short. For instance, 0·001in to 0·002in tool wear is not unusual on a long lathe cut. Naturally, a tapered workpiece would be the result, and more finishing cuts are required than would be the case in cutting steel. This wear problem is a constant factor in all machining operations and increases the difficulty of holding close tolerances.

The beryllium material used in the manufacturing of the BR-2 parts was produced by the Brush " QMV " process from magnesium reduced beryllium fluoride. The resulting beryllium metal pebbles are vacuum melted and cast into ingots weighing about 70 lb. These ingots are unsuitable for working operations or machining a product ; consequently, they are machined into chip form. These virgin metal chips are attritioned between revolving plates to minus 200 mesh powder. This powder is blended with powder recycled from other fabrication operations to produce blend grade of beryllium. This recycle blending is essential to achieve economy of beryllium manufacturing since many operations recycle 90 per cent or more of the input material. The major impurities picked up between the virgin powder stage and the blend powder recycle stage are the oxide and small amounts of iron. These do not greatly affect the nuclear characteristics of the beryllium, but do tend to modify and improve its mechanical properties. The typical chemical composition for this project was 98·8 per cent beryllium, 1·3 per cent BeO, 0·13 per cent Fe, 0·05 per cent Al, 0·013 per cent Ni, 0·01 per cent Mn, 2 p.p.m. Co, 1 p.p.m. B, and 0 to 3 p.p.m. Li. The ultimate tensile strength was 52,000 lb per square inch ; yield strength, at 0·2 per cent offset, was 43,000 lb per square inch ; and elongation was 2·5 per cent average. The blend powder was hot pressed to a final density between 1·84 grammes and 1·855 grammes per cubic centimetre, or substantially 100 per cent of the theoretical density.

### Lear, Incorporated

An interesting rod positioning system for nuclear reactors was demonstrated at the stand of Lear, Incorporated, Grand Rapids, Michigan. In this " Leartron " rod positioner, two basic servo units were combined to form a system of exceptional accuracy, response and flexibility. The positioner consists of two separate closed loops ; one for driving the reactor control rod and one for driving a digital read-out device. The scram speed control is obtained with a magnetic particle clutch and brake.

Two different methods of inserting command signals to the actuator are available at the control panel. For coarse positioning, a keying switch on the panel energises a clock motor, which drives the command synchro. The gear ratio between the motor and the synchro determines the speed of the rod. The flexibility of the system is increased by a design which permits the changing of this ratio. For fine positioning, a " push-to-turn " knob is provided. The knob is coupled, in a 20-to-1 gear ratio, with the same motor-driven command synchro. Signals from the command synchro are fed to the input of an amplifier, which amplifies and discriminates the signal and provides d.c. energisation to the proper clutch in the actuator drive servo. The amplifier also contains a power supply which furnishes anode and grid voltages, generates a 1600 c/s synchro-carrier voltage to obtain improved synchro resolution and has circuitry providing an electronic rate feedback, thus eliminating the need for a mechanical rate transducer.

The drive servo consists of a 60 c/s a.c. motor driving two contra-rotating magnetic particle clutches. The output pinions of the clutches are geared to a common output shaft so that the energisation of one clutch gives rotation in one direction and energisation of the other one gives rotation in the opposite direction. A synchro identical to the command synchro is geared to the output shaft and provides position follow-up intelligence, closing the loop. Another synchro provides command information to the indicator loop. The output of the servo is geared through several stages of spur and worm reduction and a magnetic particle clutch to the cable-drum output. Two cable drums, each capable of carrying a minimum of 150 lb, are incorporated in the device. Adjustable limit switches, driven by control gearing and cams, are set at 0, 108in and 144in of cable travel. The normal operating stroke was 108in in the particular device exhibited. A switch is provided to over-ride the 108in limit switch for rigging purposes.

The indicator loop of the rod positioning device is identical to the drive loop except that the output shaft of the magnetic particle clutch servo drives a five-digit counter instead of the cable drum. After a scram operation, the " down " clutch of the indicator servo is automatically energised and drives the servo to zero-indication to re-align the indicator with the true position of the rod. In addition to the read-out servo and coarse and fine positioning controls, the control panel also contains upper and lower limit lights, calibration lights, a " gang " operation light and all necessary interlocking relays.

The heart of the scram system is a Lear magnetic particle clutch and brake, in which the torque is directly proportional to the excitation current. When scram action is started, the clutch is de-energised and its body is held by an irreversible worm. As scram continues, the output of a permanent magnet d.c. velocity generator, driven by the falling control rod, is applied across the clutch. The faster the rod falls, the faster it drives the generator, thus increasing the energisation and, therefore, the torque of the clutch, which is now acting as a brake. As the rod continues to fall, a switch is actuated, discharging a bank of capacitors across the brake. This saturates it and produces the full braking torque of 200in-lb.

### Thompson Ramo Wooldridge

The Tapco Group of Thompson Ramo Wooldridge, Incorporated, Cleveland, Ohio, announced at the exhibition that it now has in operation a new facility for the decontamination of nuclear mechanisms and components prior to rework and overhaul. Believed to be the only commercial facility of its kind in the United States, it completes the firm's ability to serve the growing component fabrication programme of the industry. The facility has been designed for the decontamination of pumps, valves and pressure vessel heads as well as control rod drive mechanisms, utilising specially adapted machine tools, handling mechanisms and ultrasonic cleaners. Although the decontamination facility is presently licensed by the U.S. Atomic Energy Commission to possess up to 500 millicuries of radioactivity at any one time, a request for the extension of this limit to 1 curie is now being considered. The firm recently completed the decontamination inspection and testing of thirty-two control rod drive mechanisms from the reactor in the nuclear power station at Shippingport for the Bettis Atomic Power Division of the Westinghouse Electric Corporation.

The facility covers 4500 square feet and includes a completely enclosed, atmosphere-controlled area of 1200 square feet designed to maintain the standards of cleanliness required for the dis-assembly and " scrubbing " of critical precision assemblies. The " clean " room is equipped with stainless steel tables and cleaning tanks, distilled water facilities, effluent hold-up tanks and other essential equipment. Although the level of radioactivity on the parts handled to date has been extremely low, maximum precautions have been taken to protect the employees working in the decontamination area as well as the residents of the surrounding community. A room adjacent to the clean area houses radiation standards and monitoring equipment, which are under the constant supervision of health-physicists. The Nuclear Science and Engineering Corporation of Pittsburgh, was employed by the company to establish health physics procedures. The level of radioactivity encountered to date has been only 900 milliroentgens, but conservative operating procedures are being used from the outset to condition the personnel for the safe handling of more highly contaminated nuclear components in the future.

The display of the Tapco Group also stressed a magnetic " jack " mechanism developed as part of a complete control rod actuation and position indication system designed for use in a pressurised water portable power reactor. As the name implies, vertical motion is effected in discrete steps of 0·080in and at a rate of 2in and 6in per minute by magnetic forces acting through the pressure vessel wall. With the hold coil energised the segmented rod bundle is held in a static position as a result of its radial deflection against the holding armature which is fixed to the pressure vessel. This holding force is equal to the product of the coefficient of friction between the rod bundle and the armature, and the radial magnetic force of the hold coil.

The sequence of operation for lifting is as follows : (1) The grip coil is energised, deflecting the rod bundle radially out against the gripping armature which is free to move an increment of 0·080in. (2) The hold coil is de-energised, freeing the rod bundle and gripping armature for movement. (3) The lifting coil is energised, raising the gripping armature and rod bundle 0·080in. (4) The hold coil is energised which retains the rod bundle in the raised position. (5) The lift and grip coils are de-energised, allowing the gripping armature to fall back 0·080in to its starting position. This sequence is then repeated for lifting, while for lowering it is reversed. A spring assist results in a scram time of 350 milliseconds and a power failure results in automatic scramming.

In the interest of extremely long life and minimum maintenance the firm has devised a control and position indication system which is completely transistorised. Coil sequencing is accomplished using a square wave generator whose pulses are referenced to one oscillator and two R-C networks. This method of timing is extremely accurate as a result of virtually zero drift over the temperature range which it must operate. Position indication is accomplished using a linear differential transformer situated outside the pressure vessel and a slug affixed to the top of the rod bundle. The transformer is mounted on a ball screw driven by a null-seeking servo motor which is directed by the transformer error signal. The position of the transformer is measured by a synchro transmitter and displayed on a dial indicator. The reduction in moving parts, the elimination of a seal or canning problem, as well as other simplifications and improvements in the mechanism and its associated components, have resulted in a system of great reliability and low cost.

### A.M.F. Atomics

Several models of research reactors were shown at the stand of A.M.F. Atomics, a division of the American Machine and Foundry Company, Greenwich, Connecticut, with particular interest being attracted by the firm's light-water moderated tank research reactor. Combining inherent safety with a maximum number of experimental facilities, the tank reactor is designed to provide the high flux levels frequently called for in certain fields of basic and applied research. A light water moderated, solid fuel reactor, employing water as the coolant and shielding, the light-water tank reactor incorporated a number of significant operating advantages. Visibility of the core is maintained through the use of transparent shields. These light-weight, removable shields simplify the re-arrangement of core loading, provide quick access to the irradiation space in the water tank, and yet offer all the advantages of an enclosed metal vessel. Highly compact for a reactor of its power and numerous experimental facilities, the tank reactor requires a building of minimum size, contributing to economy of space and construction costs. The controls are of the overhead design ; they are thus not only protected from the undesirable effects of high humidity, but are easily accessible for inspection and maintenance.

The numerous experimental facilities offered in the A.M.F. tank reactor, together with the high fluxes available, facilitate a wide range of studies, in practically every field of nuclear research. The reactor design includes facilities

for bulk and gamma radiation, as well as numerous independent beam holes for physics research and hot loop experiments. It can easily be converted into an engineering test facility, and may include further modifications such as a canal or hydraulically operated pass-through tube with little or no effect on the facilities inherent in the basic design. A typical installation includes seven 6in diameter beam tubes, one 12in square beam tube, one pneumatic rabbit loop, one hydraulic rabbit, one thermal column, one engineering test facility, two 6in diameter through-tubes, a substantial bulk irradiation area, and a dry, gamma radiation facility.

Drawing upon its long and highly specialised experience in the development of control systems, the firm has incorporated advanced control and safety features that have been thoroughly proved in actual reactor operation. Inherent safety is provided by the use of light water as a moderator. The overhead positioning of the standard control rod drive mechanism adds further to safety and simplicity of maintenance. All elements of the completely integrated control and safety system, which allows either manual or automatic reactor operation, have been designed to afford maximum protection against mechanical or human failure. The centre of the entire control and safety system is a specially developed annunciator console. It provides the operator with a complete and constant picture of reactor operation through the various read-out devices. Furthermore, the annunciator console gives instant visual and audible warning of any unsafe condition, provides automatic correction or shut-down, and indicates the cause of the unsafe condition.

Designed for maximum experimental capacity, the A.M.F. tank reactor may be operated at power levels ranging from 100kW low level operation to 5000kW for the higher fast and thermal neutron fluxes often required. Systems with higher power levels are available for those instances where such levels are required. The employment of the firm's core grid design, which includes movable control rod guides and positive hold-downs, provides unusual flexibility of flux patterns and power levels at the various facilities. By re-arranging fuel elements, control rods and the canned graphite reflectors, both the flux level and the ratio of fast to thermal neutrons can easily be distributed to meet specific research requirements.

### Union Carbide Nuclear Company

A model of the Molten-Salt Fuel In-pile Loop Experiment was displayed at the stand of the Union Carbide Nuclear Company, Oak Ridge, Tennessee. The in-pile loop was designed to test fuel and container materials for high-temperature molten-salt-fuelled reactors. The fuels tested currently in this loop are mixtures of uranium fluoride, thorium fluoride, lithium fluoride, and beryllium fluoride. The container material—" INOR–8 "—is a new alloy developed specifically for resistance to corrosion by fuel salts. The new alloy has, in addition, the fabrication properties required for a reactor structural material. The fuel and container materials were developed at Oak Ridge especially for use in the molten-salt-fuelled reactors.

The loop was designed for operation in the M.T.R. HB–3 beam hole and is divided into three regions separated by hermetically-sealed bulkheads. The forward section contains the primary loop circuit, heat exchanger and pump. The intermediate region contains the pump bearing housing, hydraulic pump drive motor, and conduits, junction boxes and hermetic seals for electrical and instrumentation leads. The rear section is a concrete-filled shielding plug through which all service lines pass to the loop.

The intermediate and forward loop sections are housed in a stainless steel water jacket to provide the cooling necessary for the protection of the beam hole tube. The primary loop circuit consists of an " INOR–8 " tube through which the fuel is pumped. The tube is formed into a hairpin loop with a helical coil in the high flux, or nose end, to increase the exposure of fuel to neutron radiation. The pump is situated at the end opposite the nose coil. An air-cooled heat exchanger, with a double wall over the fuel tube, is situated on one leg of the loop between the nose coil and the pump. Electric heaters are provided for preheating and for maintaining the high-melting salts at temperatures above the freezing temperature when the reactor is shut down.

The loop is gravity-filled, after insertion in the beam hole, from a fill tank into the expansion tank of the pump. The fill tank and lines are designed so that the correct level of fuel is automatically established in the pump. The regenerative turbine pump is capable of priming itself. The loop is insulated from the water jacket by stainless steel shim stock and quartz wool. Chromel-Alumel thermocouples are spot-welded to the fuel pipe and insulated by ceramic beads. The loop instrumentation and auxiliary equipment form a completely integrated unit tailored to fit requirements of the experiment and reactor. A single panel contains instruments for the control of air compressors for circulating the cooling air, a hydraulic power unit for driving the pump, gas pressurisation and purge systems, radiation monitoring equipment and reactor control circuits. The controls are designed to handle automatically any of the normal operating conditions, such as reactor shut down and start up. Any operational abnormalities are detected and reported by an alarm system. The loop is designed so that at least two failures must occur before a condition hazardous to reactor or personnel can exist. To seal radioactive gases, the instrument and electrical circuits pass through a double set of hermetic seals. The piping and conduits pass through two sealed bulkheads.

A purge gas is channelled over the primary circuit and through grooves between the walls of the double-wall heat exchanger. The effluent of this circuit is monitored for activity, which would indicate a leak in the fuel lines, and then passed through fission-gas traps before being vented to the M.T.R. off-gas system. The purge gas system also provides a cover gas over the free surface of the fuel in the pump sump to remove gaseous fission products. The effluent of this system is passed through refrigerated charcoal traps. The position of the loop in the beam hole is adjusted to control the neutron flux to which the fuel is exposed.

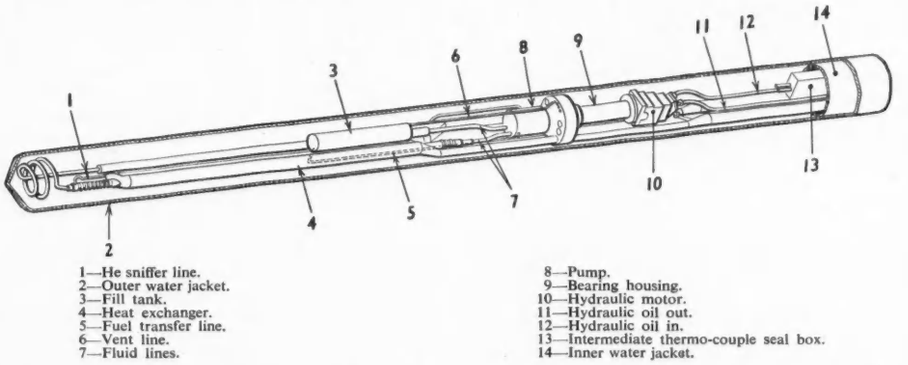



**Fig. 22—Molten-salt fuel in-pile loop experiment being employed in the materials testing reactor at Oak Ridge**

### Martin Company

The Martin Company, of Baltimore, Maryland, exhibited several nuclear devices employing the idea of isotopic power. The principles underlying isotopic power are simple. Heat is generated when the particulate or electromagnetic radiations emitted by sealed isotopes are absorbed in the surrounding containment material. A portion of this heat is converted to electricity by a suitable energy conversion device; the rest is dissipated to the external environment. Since the isotopes are obtained primarily from fission products, the utilising of these nuclear wastes as a further power source is economically analogous to the meat packers' processing of horns and hooves into useful by-products. A costly economic liability becomes an additional asset.

The capabilities and limitations of isotopic power arise from both the technical and economic principles. The principal technical factors involved are the half-life of the isotope selected and the efficiency of the conversion devices available. Use can be made of long-lived isotopes of very moderate power-producing ability or the shorter-lived isotopes can be used. With the shorter-lived isotopes a penalty of either a short power supply life or more massive heat dissipation apparatus must be tolerated. The latter is required to reject a considerable amount of energy early in the life of the power supply if a constant power output is required. Thermo electric, thermionic, and turbo-electric conversion devices are all feasible for specific applications. The energy conversion system chosen is very heavily influenced by the end-use or mission requirements, frequently to such an extent that the conversion efficiency is overshadowed. The availability of suitable isotopes in very large quantities is at present temporarily limited because there is no suitable separation facility in existence. The supply of feed material for such a facility is ample. The construction of a separations facility would make fission products available in large quantities and would also provide some isotopes at less than one-tenth of to-day's prices. Mixed fission products are not usable as such because of their low power densities, and separation and purification of specific isotopes from these products is required for power applications.

The conversion of the heat produced by isotopes into electricity is a problem which is independent of the isotope selected as fuel. Three basic schemes may be used: turbo-electric, thermo-electric, or thermionic devices. Much experience has been gained in the use of conventional rotating equipment and abundant design data are available. However, turbo-electric systems lose efficiency rapidly at power levels below 1kW. Thermo-electric conversion offers exceptional reliability, silent operation, and attractive safety features. The present state of the art in thermo-electricity is sufficiently advanced to encourage its immediate use. Thermionic conversion, holds great promise, but is not nearly as well developed at present as thermo-electric conversion. The physical principle of thermo-electric conversion is the Seebeck effect, which has been known since 1821. When two dissimilar metals are connected to form a closed loop, and the ends are at different temperatures, an electric current will flow. One of the elements, the " N " type, has surplus electrons; the other element, the " P " type, is electron deficient. The surplus electrons and deficiencies or " holes " are the charge carriers and migrate in the direction of the decreasing temperature. Thus the current in the " P " or positive element flows from the hot to the cold junction, while in the "N" or negative element, the electrons move from the cold to the hot junction.

The surplus heat must be removed by radiation, conduction, or convection. For space applications, only radiation can be used and radiator design problems frequently become the great barrier problems in designing power supplies. The feasibility of producing practical power from isotopes was demonstrated by the firm last year with the initial operation of SNAP III, a Polonium–210 fuelled thermo-electric generator. The success of this programme provided considerable technological incentive to investigate the use of other fuels for generating heat and power to perform unattended missions of long duration on land and under the sea.

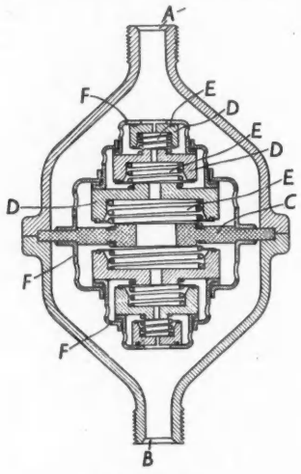
# BRITISH PATENT SPECIFICATIONS

*The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each*

## SHOCK ABSORBERS

**835,805.** August 1, 1957.—SHOCK ABSORBERS, Recherches Etudes Production R.E.P., 38, Avenue Pierre ler de Serbie, Paris 8e, France.

The shock-absorber or damping device described is more generally intended for pneumatic suspension of vehicles, and particularly but not exclusively intended for monochronous suspensions with the object of damping large amplitudes of frequencies of suspension. The shock-absorber body is mounted on the chassis of the vehicle and connected at *A* to the bellows of the suspension and at its opposite

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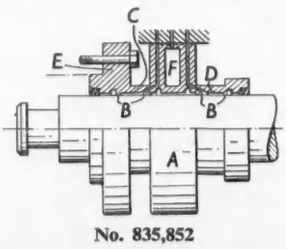
extremity *B* to the auxiliary chambers. At the centre is fixed a diaphragm *C* and, on each side of this diaphragm, a series of masses or weights *D* respectively thrust by calibrated springs *E*. Each of these weights is limited in its movement along the axis by a thrust-cage *F* and calibrated orifices are formed both on the diaphragm and on the weights. At the periphery of each of the thrust cages are orifices which are uniformly spaced. The operation of the device is as follows : Under the action of vertical accelerations, the weights compress their spring in the direction which corresponds to that of the acceleration in action. If this acceleration is sufficient, the weights come into contact, one with the diaphragm and each of the following against that preceding, as and when the acceleration increases. By choosing in a suitable manner the number and the value of each of the masses or weights, and also the calibration of the corresponding springs and the orifices, it is possible to obtain the damping desired for each of the two directions of operation of the members of the suspension. The device can be employed for any direction of the accelerations, transverse, longitudinal, &c.—*May* 25, 1960.

## MACHINE TOOLS

**835,852.** April 11, 1958.—INCHING MECHANISM, Sperry Gyroscope Company, Ltd., Great West Brentford, Middlesex. (*Inventor : Henry James Cyril Weighell.*)

This invention relates to a mechanism for effecting inching movements between two relatively-slidable members, for example, the table and wheelhead of a grinding machine. An embodiment of the invention is

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described, by way of example only, with reference to the accompanying drawing showing a part-sectional elevation of a linear actuator for finely adjusting the wheelhead of a grinding machine along the bed. The support member of the wheelhead (not shown) consists of a horizontal shaft located and supported within a generally cylindrical bore in a clamping member *A* bolted on to the bed of the machine. The diameter of the bore is somewhat larger than that of the shaft except near each end, where a pair of axially-spaced lands *B* normally grip the shaft tightly. Between the lands of each pair is formed an annular chamber *C* and *D* around the shaft. The clamping member *A* has a wide parallel-sided flange midway between the two ends and a narrow flange *E* having holes for bolts by means of which the member is bolted to the bed of the machine. Within the wide flange is an annular expansion chamber *F*. The chambers *C*, *D* and *F* can be supplied with hydraulic fluid under pressure through one of three passages in the flange. The fluid may be independently supplied at controlled pressures to each of the chambers. Each pair of lands *B* acts normally as a clamp preventing relative movement between the member and the shaft, but when one of the chambers *C* and *D* is pressurised, the part of the clamping member which forms the chamber wall expands and the clamp at that end is released. When the expansion chamber *F* is pressurised—provided one of the clamps has been released—the clamping member expands axially at the annular walls forming the inner and outer walls of the chamber, so that the spacing between the clamps increases. To adjust the position of the shaft relatively to the clamping member *A* fluid is admitted into the chamber *D* to release the right-hand clamp. Fluid is then admitted to the chamber *F*, and the consequent expansion causes a small movement of the right-hand end to the right relatively to the shaft. The fluid pressure in chamber *D* is then released to re-engage the right-hand clamp at a point further along the shaft from the point where it was originally gripped. Pressure fluid is then fed into the chamber *C* releasing the left-hand clamp, and then the pressure in the chamber *F* is released. The release of pressure in the chamber *F* allows the clamping member to contract to its original dimensions, so that the left-hand clamp follows the movement of the right-hand clamp. On releasing the pressure in the chamber *C* the shaft is again firmly gripped by both clamps. By repeating the process, the clamping member can be inched along the shaft. The size of each incremental movement is determined by the frictional resistance of the load, the pressure of the fluid in the chamber *F*, the inertia of the load connected to the shaft, the stiffness of the various members concerned, and the time during which pressure is applied if this time is not long enough for a stable condition to be reached. It is believed that with this mechanism an accuracy of about 0.00001in can be achieved in the relative positioning of the head and bed.—*May* 25, 1960.

## FURNACES

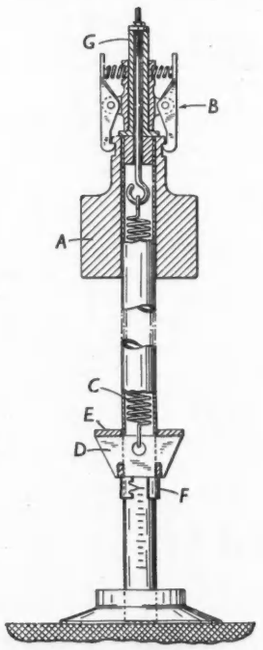
**836,287.** February 4, 1958.—ROTARY DRUM FURNACES, Demag Aktiengesellschaft, Wolfgang-Reuter-Platz, Duisburg, Germany.

The invention relates to apparatus for the refining of steel in rotary drum furnaces. In the refining of steel, rotating cylindrical drum furnaces into which the refining agent, which is advantageously oxygen or air enriched with oxygen, is introduced through one or more lances have recently been used, in addition to the conventional converters with good results. In the furnaces, the rotational movement of the furnace drum about its horizontal axis, and the generally unilateral pressure produced by the jet of refining agent directed at an angle to the metal in the bath results in a movement of the bath. In accordance with the invention, it is proposed to superimpose the rotational movement about the horizontal axis of the drum and the movement produced by the refining agent jet on an additional movement, by imparting to the drum a slow rocking or see-saw movement about a horizontal transverse axis which may itself be provided to be movable, to a maximum of a few degrees of angular movement. Generally a rocking motion of a few minutes angle, up to a maximum of 1 deg. angle, will be sufficient. It is sufficient if a single rocking movement is carried out for approximately one minute. The rocking movement affords particular advantages in two respects : first and most important, it ensures uniform refining of the whole bath. It has also been found that the lining of the drum is uniformly worn instead of there being a substantially increased wear of the lining at positions close to the so-called " burn-spot " produced by the refining agent lance. The wear of the drum lining is rendered uniform equalised, and the period of operation of the furnace is extended. Finally, local overheating in the bath is avoided, so that the quality of steel is substantially improved. The specification includes drawings and details of furnaces fitted with rocking gear.—*June* 1, 1960.

## TESTING MACHINES

**836,023.** August 2, 1957.—APPARATUS FOR TESTING THE RESISTANCE TO IMPACT OF A MATERIAL, Rolls-Royce, Ltd., Nightingale Road, Derby (*Inventor : Frederic Francis Allwood.*)

The impact resistance apparatus shown comprises a base which is supported by the material to be tested. A tubular column on the base has a freely-sliding weight *A* supported through a release mechanism, generally indicated at *B*. The column houses a tension spring *C*, the upper end of which is adjustably anchored by a hook member with a threaded stem. The lower end of the spring engages through a hole in a plate *D* which slides in longitudinal slots in the lower portion of the column, the plate being held against the upper ends of slots by the spring. Rings which encircle the column are secured to the

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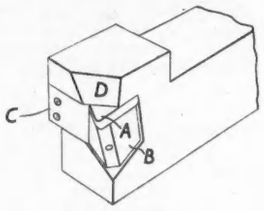
upper and lower edges of the plate, the upper ring *E* receiving the direct impact of the falling weight and transmitting the impact to the base. An indicator ring *F* which encircles the column and grips it sufficiently to prevent its sliding carries a pointer which co-operates with a graduated scale marked on the column to record the lowest point reached by the weight relative to the base during impact. In operation with the base placed on the material to be tested, the weight is released to fall freely and effectively impinge on the base by striking ring *E* so that force is transmitted through the ring, plate *D*, spring *C*, and distance piece *G* to the column. The extent to which the spring is stretched depends upon the resilience of the test material and the displacement of the lower end of the spring relative to the column is measured by the ring engaging the indicator *F* and moving it along the graduated scale. The position reached by ring *F* gives an indication of the deflection of the spring, which in turn gives an indication of the resilient properties of the material under test.—*June* 1, 1960.

## CUTTING TOOLS

**836,005.** March 26, 1957.—CUTTING TOOLS, British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor : Hubert Thomson Noar.*)

The throw-away tip tool holder has a recess which accommodates the rear portion of a triangular tip *A*

and a wedge shaped clamping member *B*. A locating member *C* is fixed to the end of the holder by screws, and a screw for holding the clamp in position extends crosswise through the holder and is tightened from the other side. The surface *D* above the tip, which acts as a "chip breaker," is entirely independent of the clamping means, and can be designed solely for its main purpose. The surface provided to bear against the top of the tip is inclined at an acute angle to the main axis of the shank in order

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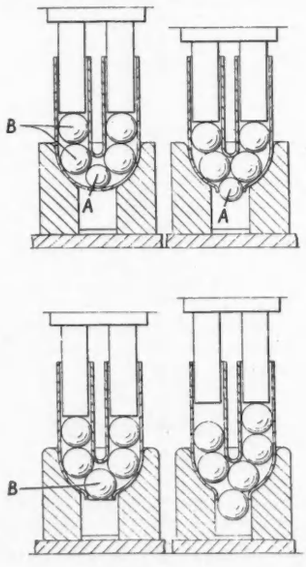
to provide a desired cutting angle. A suitable inclination may be of the order of 5 deg. in the longitudinal direction of the shank axis, and 5 deg. in the transverse direction. The lower surface of the recess or slot designed to bear against the underside of the wedge is inclined at a suitable angle to provide a wedging effect and the desired upward force on the clamp when it is introduced. The machining required on the holder is not complicated as there are no blind recesses, and its cost of manufacture is relatively low.—*May* 25, 1960.

### TUBE MANUFACTURE

**836,524.** September 17, 1958.—FORMING NIPPLES ON TUBES, Babcock and Wilcox, Ltd., Babcock House, 209–225, Euston Road, London, N.W.1.

The invention relates to methods of forming nipples on tubes and is particularly useful, for example, in forming a nipple on a radially outer curved part of a tube bend. The drawings show stages in the process. A tube bend having a curved portion connecting parallel legs is mounted in a die




No. 836,524

adapted to support the radially outer curved part. The bend has a small opening where the nipple is required, and the die supports the tube adjacent the aperture. The die is mounted on a press with two punches which enter the legs of the bend. Within the bend is a ball *A* of diameter less than the diameter of the nipple opening required. Respective pairs of balls *B* of the desired bore of the nipple to be formed, are disposed in each of the arms of the tube bend element, one on either side of the ball *A*. Operation of the press forces ball *A* down through the opening as shown and then the punches are raised and a further ball *B* of the required larger diameter inserted and forced down through the hole to form the nipple by extruding the metal around the aperture between the die.—*June* 1, 1960.

**836,021.** August 2, 1956. TUBE WELDING, Pryni Brnenska Strojirna, Zavody Klementa, Gottwalda, Narodni Podnik, 7-9, Olomoucka, Brno, Czechoslovakia.

The invention relates to a method of removing the internal burr-forming flash which occurs in electric resistance butt welding of tubes. Such internal burrs are usually removed by chiselling, firing a bullet through the tube, turning, grinding, or the like. Such operations are difficult to perform, often cause damage to the inner surface of the tube, and they increase the cost of an otherwise cheap weld. Moreover, the known methods can only be applied to straight tubes, none being suitable for removing the flash when the tubes are curved. In the method of removing the burr-forming flash in butt welding tubes, according to the invention, a gas stream is caused to flow through the tubes past the welding point and a device is provided within the tube for throttling the gas stream. It has been found that as a result of the combined effect of the gas stream and of the pressure to which the stream is subjected, a satisfactory removal of the burr-forming flash can be obtained.—*June* 1, 1960.

### INTERNAL COMBUSTION ENGINES

**836,06.** August 7, 1958.—STARTING SYSTEMS FOR INTERNAL COMBUSTION ENGINES, D. Napier and Son, Ltd., 211, Acton Vale, London, W.3. (*Inventor: Kenneth Howard Greenly.*)

This invention relates to battery-operated starting systems for internal combustion engines, more particularly, but not exclusively, aircraft engines of the gas turbine type. A conventional battery-operated starting system for such an engine comprises a starter motor connected to a battery through series resistances which are cut out progressively during the starting operation as the speed of the engine increases. The overall efficiency of such a starting system is low because a substantial proportion of the energy supplied from the battery is dissipated in the series resistances, and so the battery has to be larger than it would need to be in a more efficient system. Since batteries are relatively heavy this is a serious disadvantage in aircraft where weight saving is of paramount importance. According to the invention a starting system comprises a direct current electric motor supplied from the battery and driving a constant speed variable displacement hydraulic pump which feeds a hydraulic motor which drives the engine. Since the hydraulic pump is driven at a constant speed the electric motor can be directly connected to the battery without employing series resistances, so there is no avoidable waste of energy in the electrical part of the system. Conveniently, the system is so arranged that during the first part of the acceleration of the engine the hydraulic motor provides constant torque, up to the full power rating of the hydraulic pump, and during the remainder of the acceleration the pump operates at constant hydraulic power, i.e. the pump delivery pressure falls as the engine speed continues to rise. In this manner the characteristics of the hydraulic motor conform relatively closely to the torque-speed requirement of the engine. In the case of a gas turbine, for best results the transition from constant hydraulic torque to constant hydraulic power should occur approximately at the light-up speed of the engine, because at light-up there is an abrupt fall in the torque requirement of the engine. The torque requirement, which up to this point has been increasing with increasing speed, then begins to fall with increasing speed. When the pump is operating at constant hydraulic power, i.e. the falling delivery pressure, the torque available from the hydraulic motor falls with increasing engine speed.—*June* 1, 1960.

## British Standards Institution

*All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.*

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No. 1735 : 1960. Price 12s. 6d.

### FLANGED STEEL CHECK VALVES

No. 1868 : 1960. Price 15s.

### FLANGED STEEL GLOVE VALVES

No. 1873 : 1960. Price 15s.

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B.S. 1414 deals with cast or forged steel rising-stem, outside screw-and-yoke solid wedge gate valves with internal flanges and with butt-welding ends. The classes are : 150, 300, 400, 600, 900, 1500 and 2500 ; and nominal sizes from 1in to 24in.

B.S .1570 covers cast or forged steel lubricated and non-lubricated plug valves having straight-way ports, with integral flanges and butt-welding ends. The classes are 150, 300, 400, 600, 900, 1500 and 2500, and nominal sizes 1in to 24in.

B.S. 1735 covers flanged cast iron valves of the wedge gate and double disc gate types, with either outside-screw-and-yoke, rising-stem, or inside-screw, non-rising stem. The classes are : 125 and 250 ; and nominal sizes 1¼in to 24in.

B.S. 1868 covers cast or forged steel check valves of the swing, piston and ball types. The classes are 150, 300, 400, 600, 900, 1500 and 2500 ; and nominal sizes 1in to 18in.

B.S. 1873 covers cast or forged steel outside-screw-and-yoke type globe valves with internal flanges and with ball or plug type disks. The classes are 150, 300, 400, 600, 900 and 1500 ; and nominal sizes ¾in to 8in.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

#### ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

*To-day, June* 24.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, Films on "Installing Armoured Cables," 7.45 p.m.

#### BRITISH INSTITUTE OF MANAGEMENT

*Wed., July* 20.—Connaught Rooms, London, W.C.2, One-day conference on "A Practical Guide for Management Decisions," 9.45 p.m.

#### FEDERATION EUROPEENNE DE LA MANUTENTION

*Mon., June* 27 *to Sat., July* 2.—Stockholm, Sweden, Eighth Annual General Meeting.

#### INSTITUTE OF METALS

*Mon., July* 25.—Royal Institution, Albemarle Street, London, W.1, "The Structure of Metals and Intermetallic Compounds," Linus Pauling, 6.30 p.m.

#### INSTITUTE OF PETROLEUM

*To-day, June* 24.—EXPLORATION AND PRODUCTION GROUP : 61, New Cavendish Street, London, W.1, A symposium on Exploration and Production Methods, "Geophysics To-day," J. McG. Bruckshaw ; "Possible Improvement in Drilling," H. D. Fanshawe ; "Advances in Well Logging," P. Threadgold ; "Partial Removal of $H_2S$ from Crude Oil by Stripping with Natural Gas," T. R. Shipster, 10 a.m. and 2.30 p.m.

#### INSTITUTION OF ELECTRICAL ENGINEERS

*Mon., June* 27 *to Fri., July* 1.—Summer Meeting in Scotland.

#### INSTITUTION OF MECHANICAL ENGINEERS

*Tues., June* 28.—SOUTHERN BRANCH : Visit to the Paper Mills, Thatcham, 10 a.m.

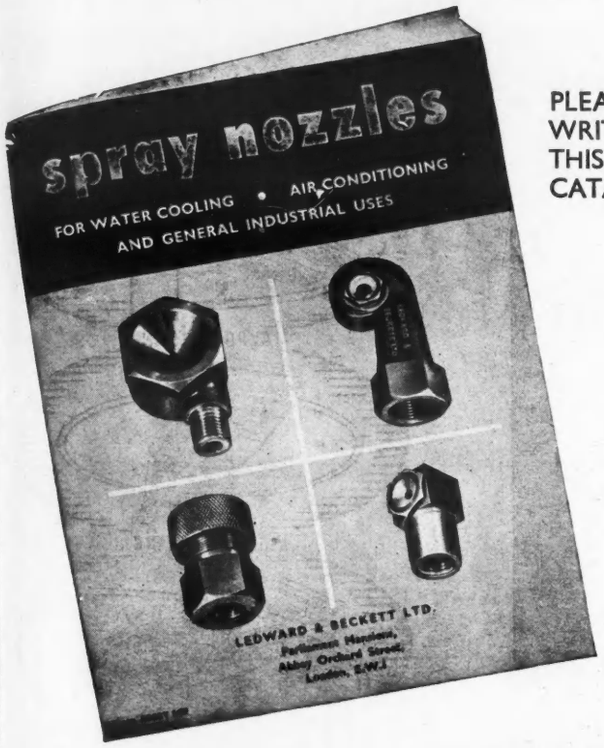
*Wed., June* 29.—SOUTHERN BRANCH : Visit to H.M.S. "Sultan," Gosport, 9.45 a.m. to 4 p.m.

*Wed. and Thurs., June* 29 *and* 30.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP AND THE EDUCATION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Informal Discussion on "Machine Tools and the User," 6 p.m.

#### ROYAL METEOROLOGICAL SOCIETY

*Wed. to Fri., June* 29 *to July* 1.—Summer Meeting at Queen's College, Dundee.

END OF VOLUME 209

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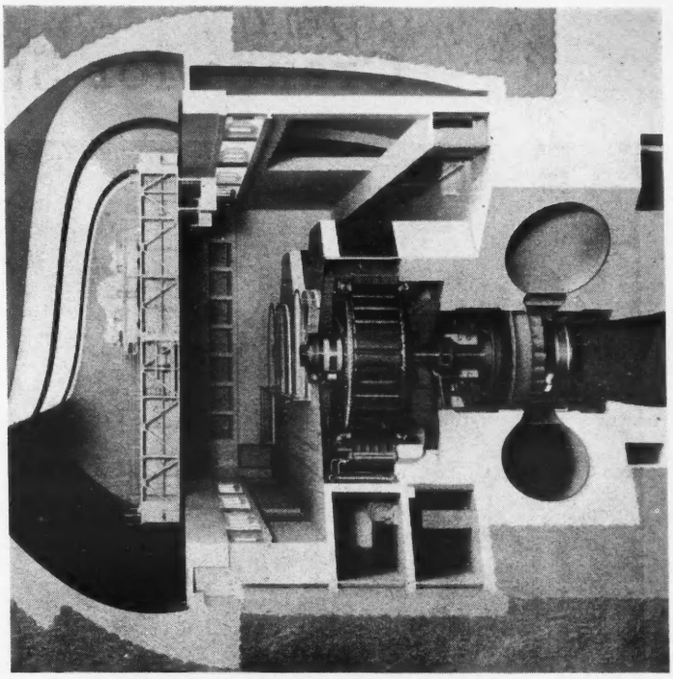

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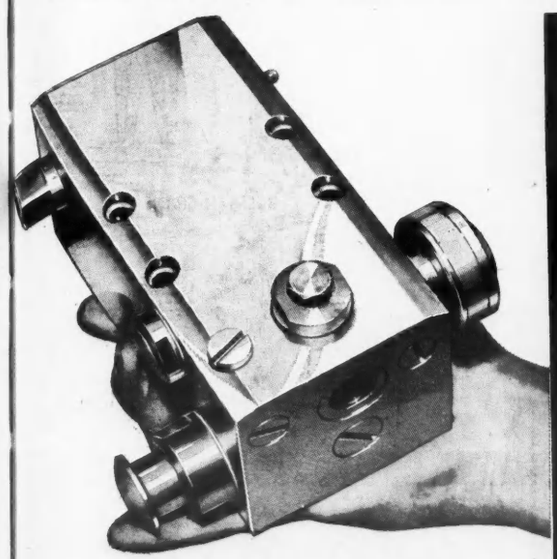

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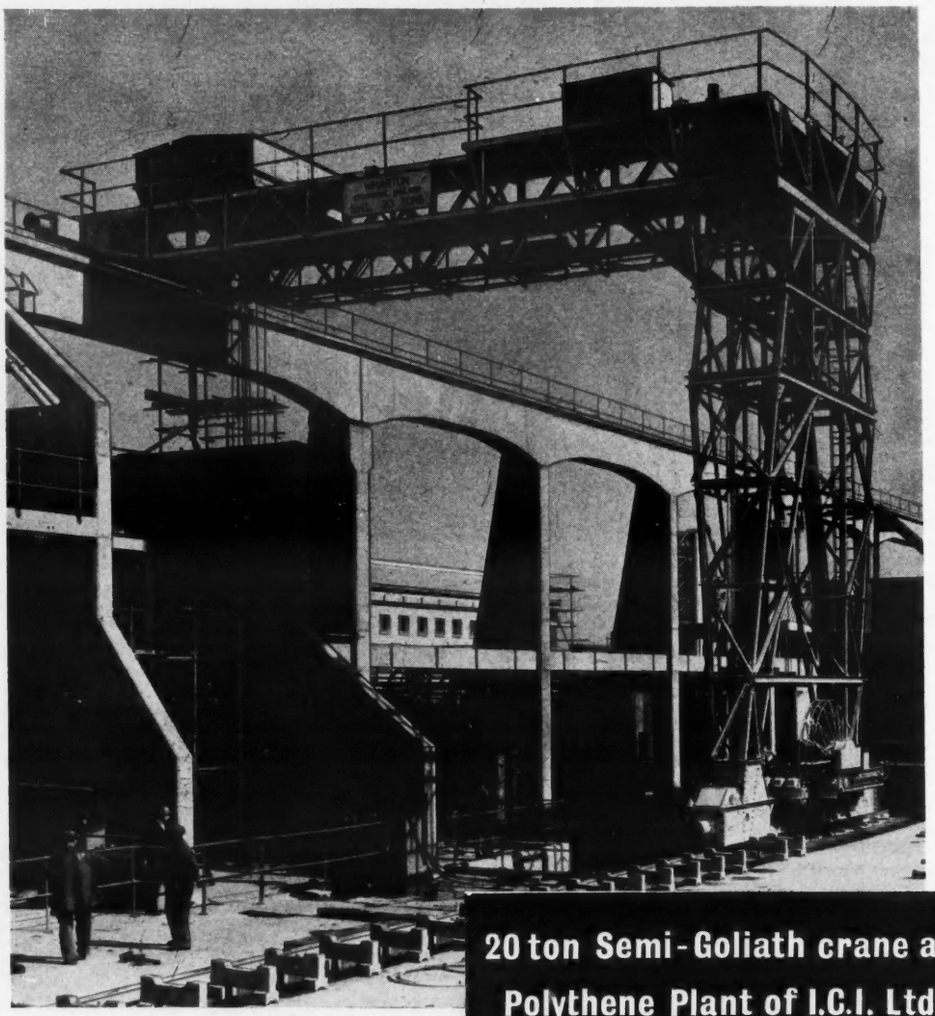

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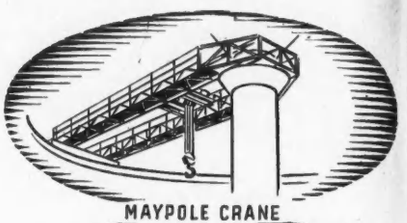

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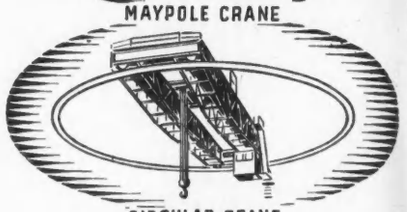

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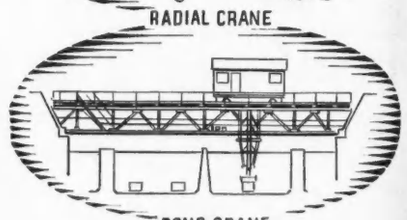

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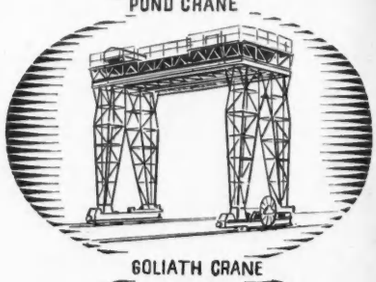

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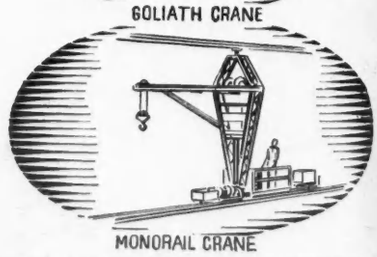

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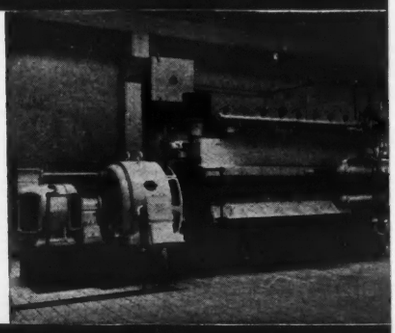

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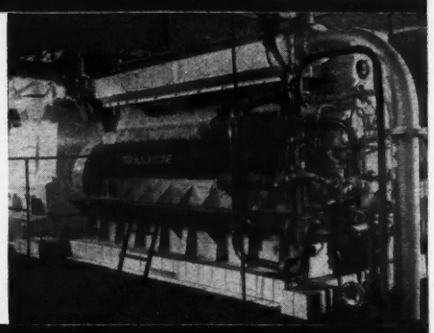

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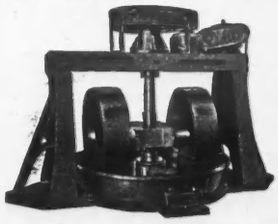

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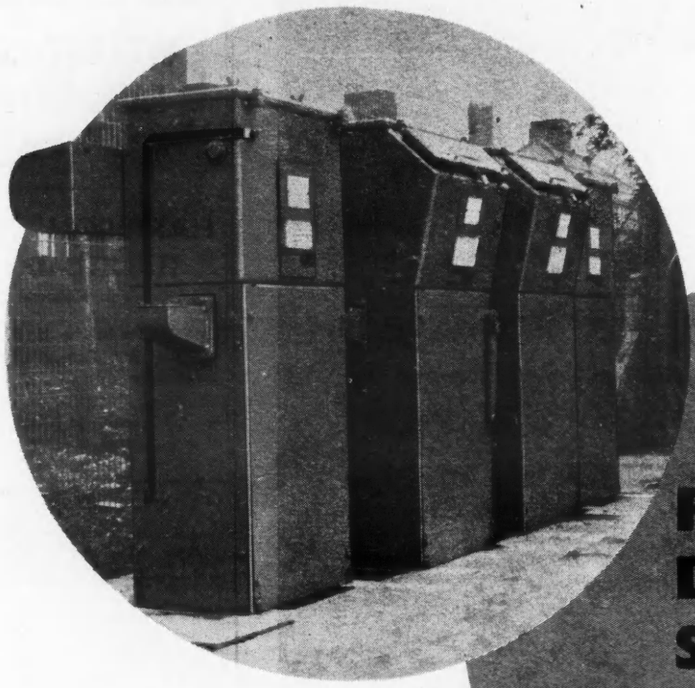

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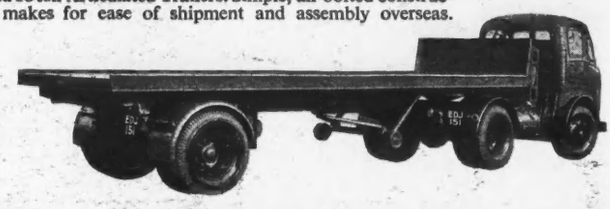

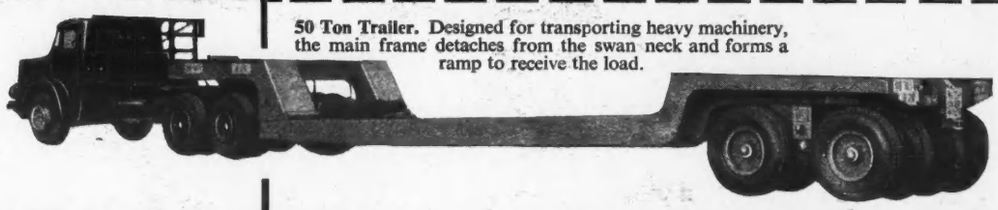

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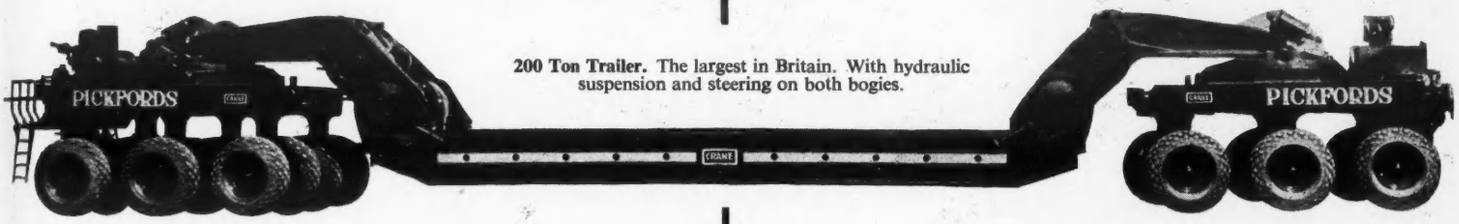


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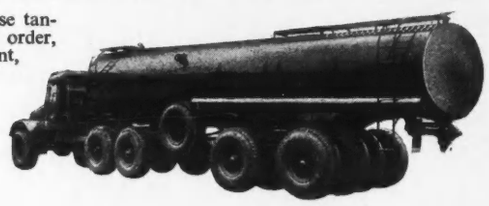

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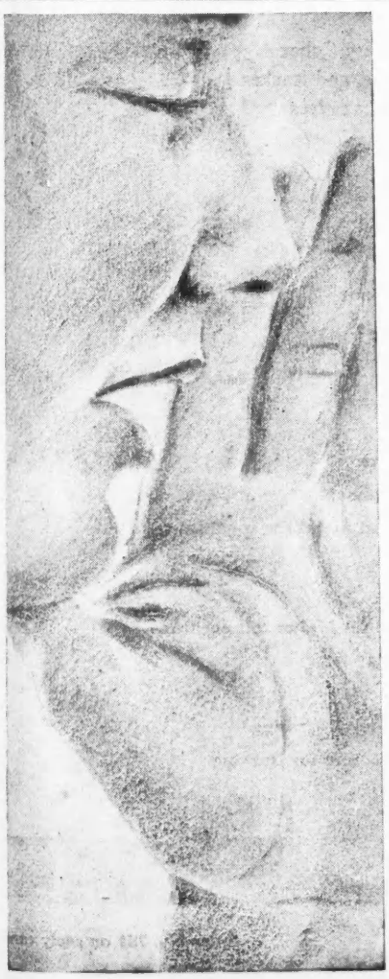

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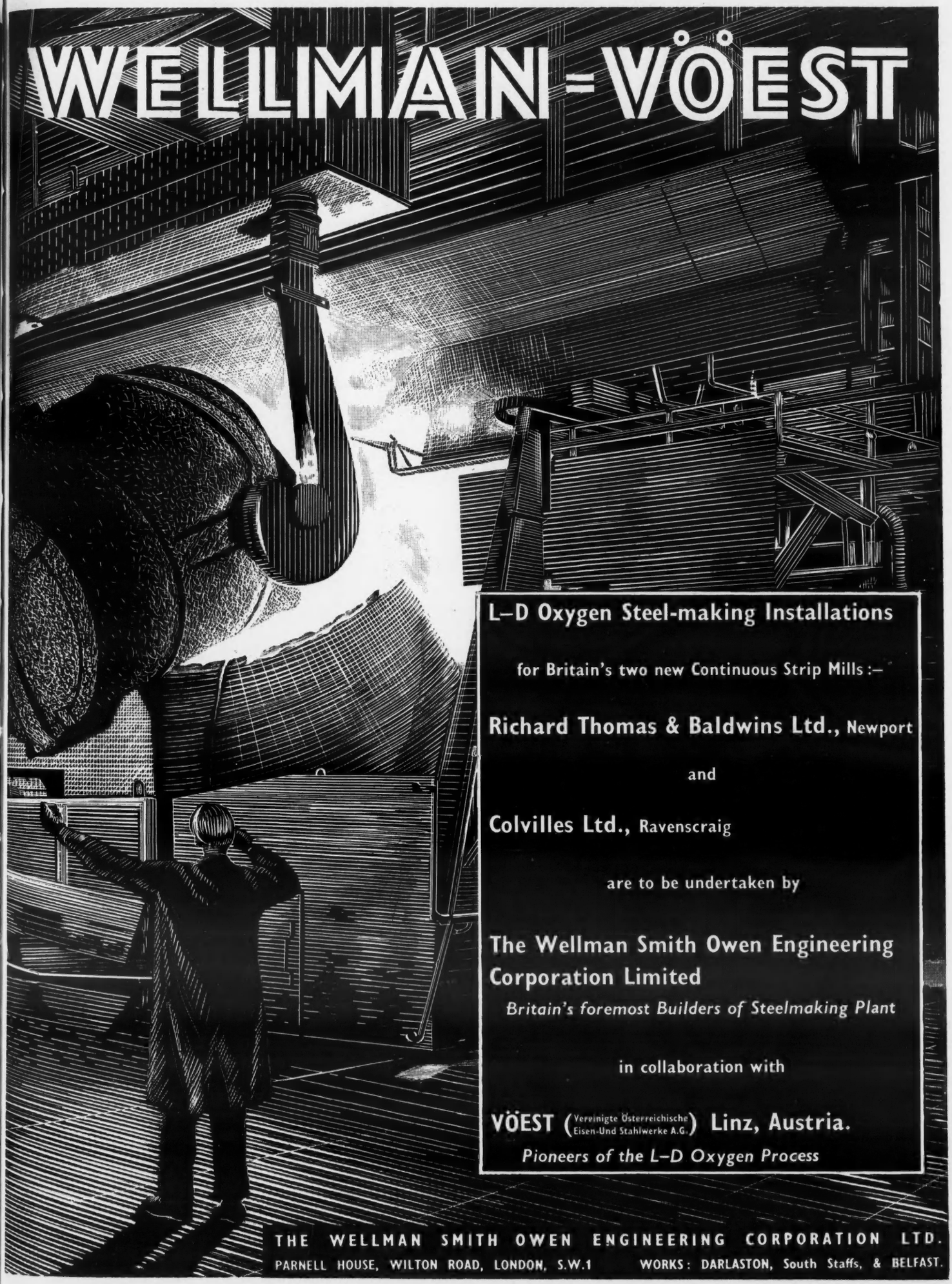

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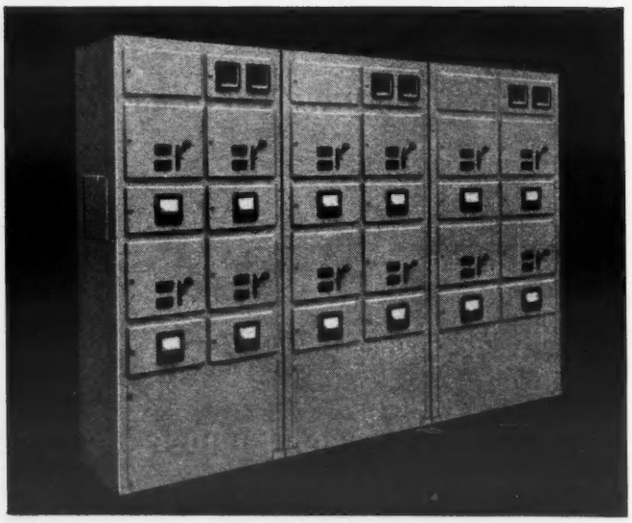

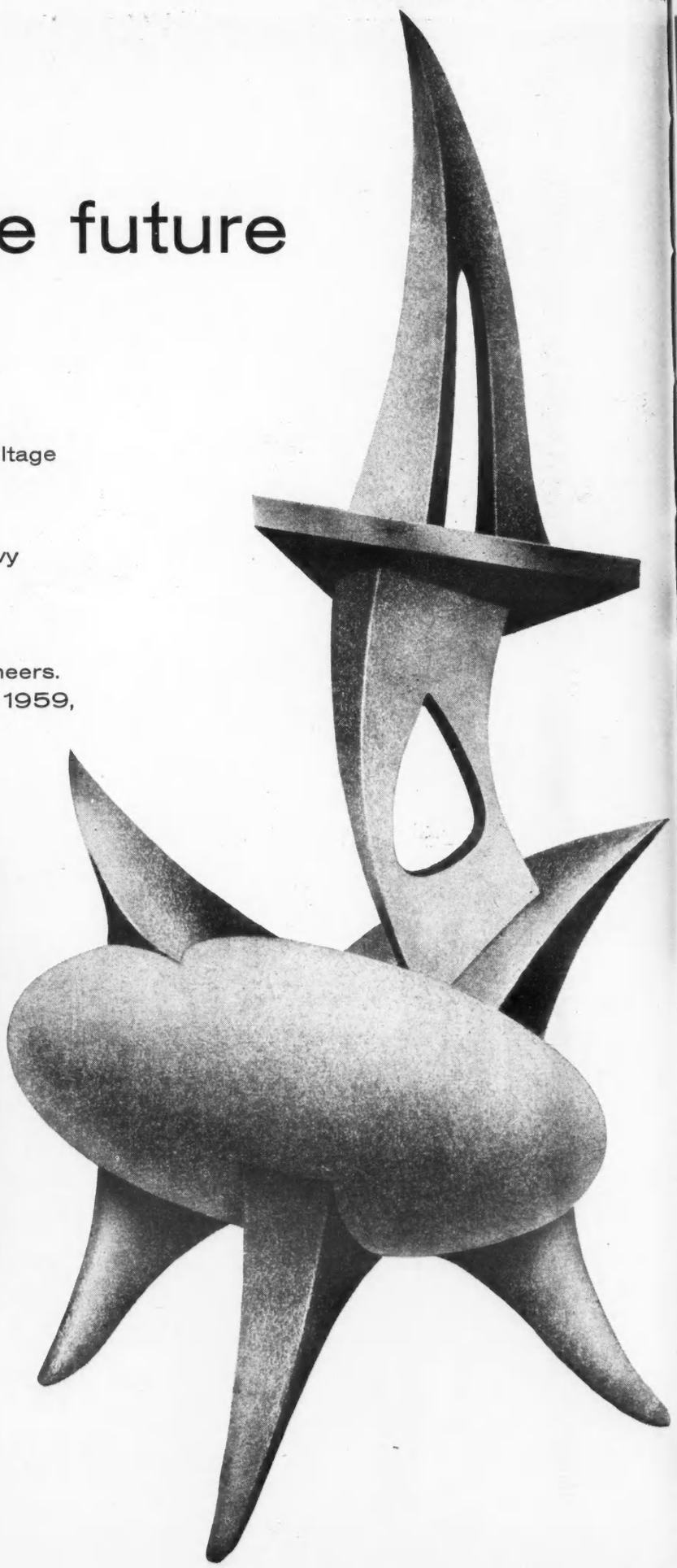

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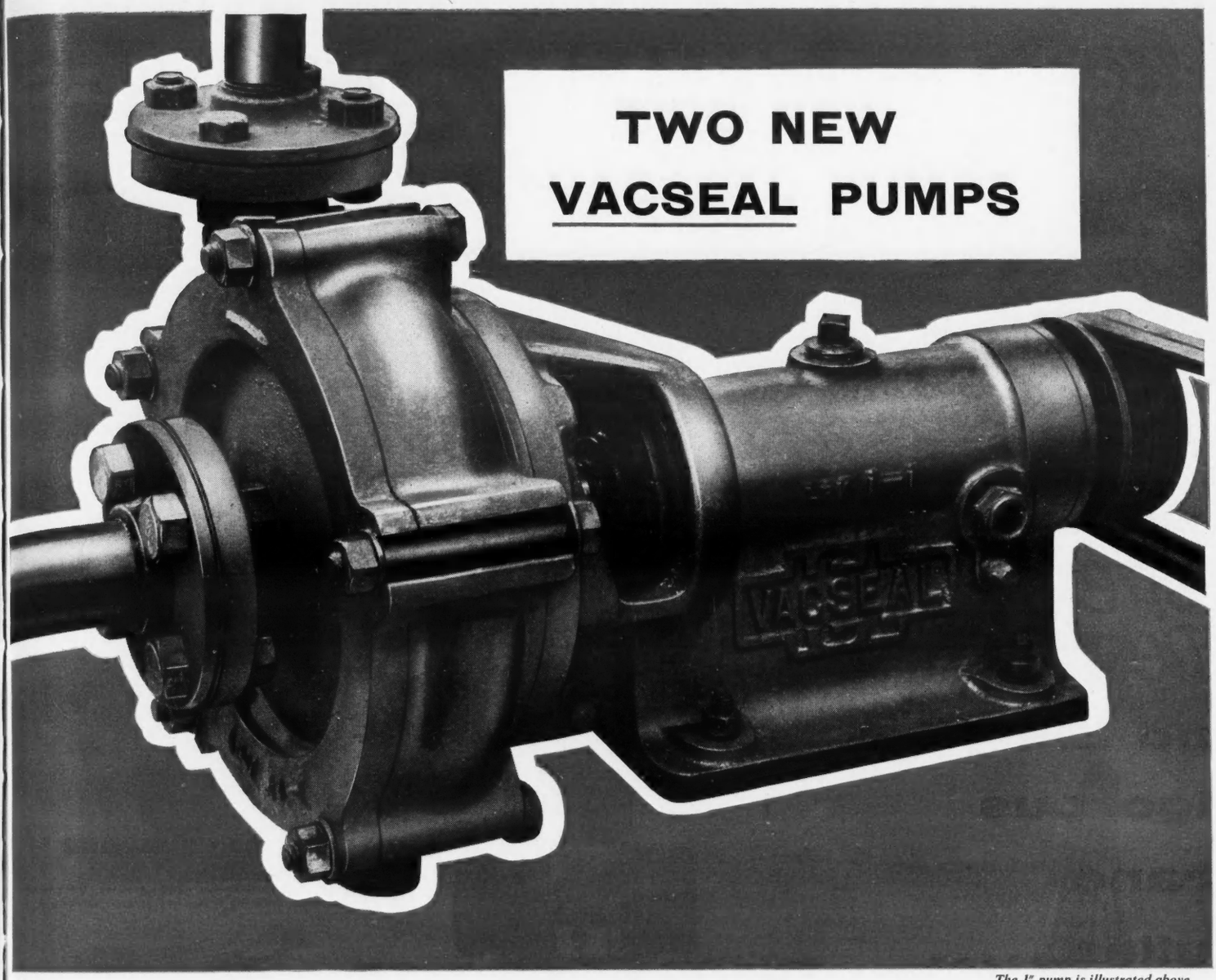


*The 1″ pump is illustrated above*

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VACSEAL *is a registered trade name.*

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# IMPRESSION

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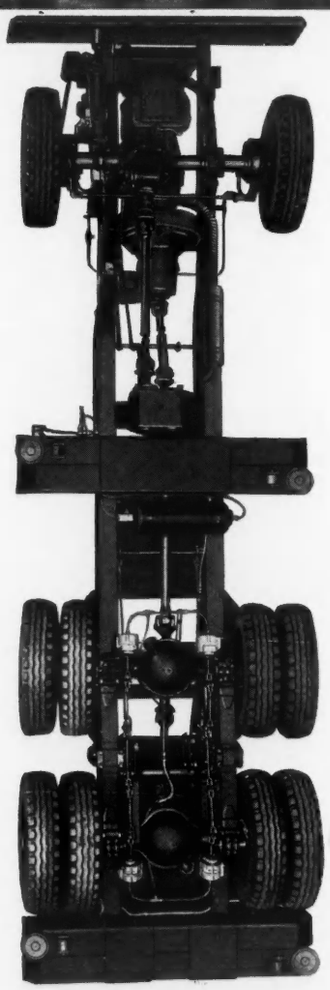
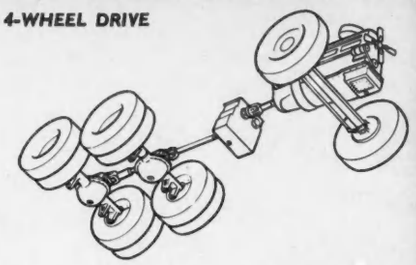
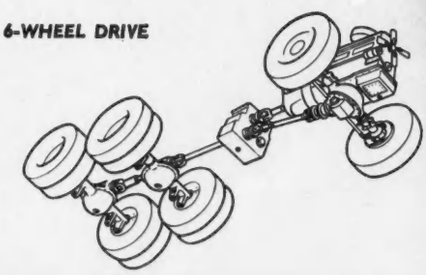


4-WHEEL DRIVE



6-WHEEL DRIVE



### SPECIALLY DESIGNED CARRIERS

The above illustrations show four- and six-wheel drive models designed to match differing travel and ground conditions.

### A TYPICAL 6-WHEEL DRIVE CHASSIS

Coles carriers are engineered as perfect units for crane service. They are not merely standard vehicles converted for crane duties but specially designed chassis built to withstand the heavy stresses and shock loadings peculiar to crane duties.

Coles range of truck mounted cranes is the largest in Europe with lifting capacities up to 50 tons. Each unit is designed and built for top performance in its class and is the outcome of 80 years experience in the field of mechanical handling.

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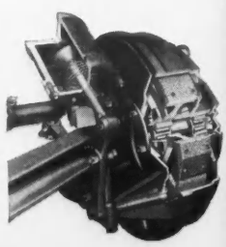
### BRAKING POWER

Power operated air brakes act on all wheels to provide gradual and sensitive braking under normal conditions and maximum safety in emergencies. In addition, a mechanical parking brake acts on the rear wheels.



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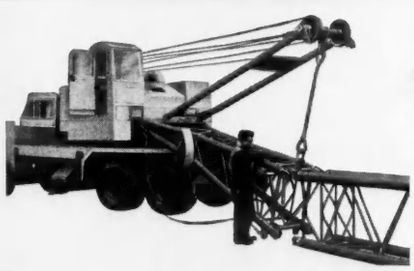
Specially designed rocking beams centrally pivoted to the chassis frame plus generous tyre equipment provide optimum flotation and maximum tractive effort for arduous, off-the-road work.

Coles **RANGER**

## DRIVER'S CAB

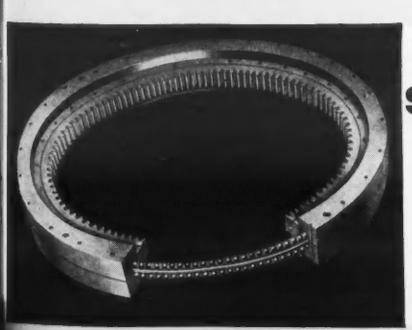
Designed for maximum comfort and efficiency Coles chassis cab is equipped with simple, finger-tip controls, large, wide vision windows and fully adjustable seat. To suit climate cab-heating equipment can be fitted or fan and demister.

Coles **CONQUERER**



## SELF ERECTING JIB

Coles self erecting jibs mean minimum idle time and consist of a gantry mast pivoted on the lower jib section and reeved into the derricking system. Jibs are pin-jointed to facilitate speedier length conversions.

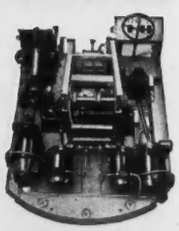


## SLEW BEARING RING

Each Coles revolves on a large diameter double live ring of steel balls running in hardened races. This double race ball bearing obviates the need for a centre-post and gives more even distribution of loading on the chassis frame.

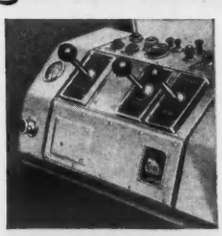
Coles **AENEAS**

## DIESEL-ELECTRIC TRANSMISSION – *A power for good in handling*

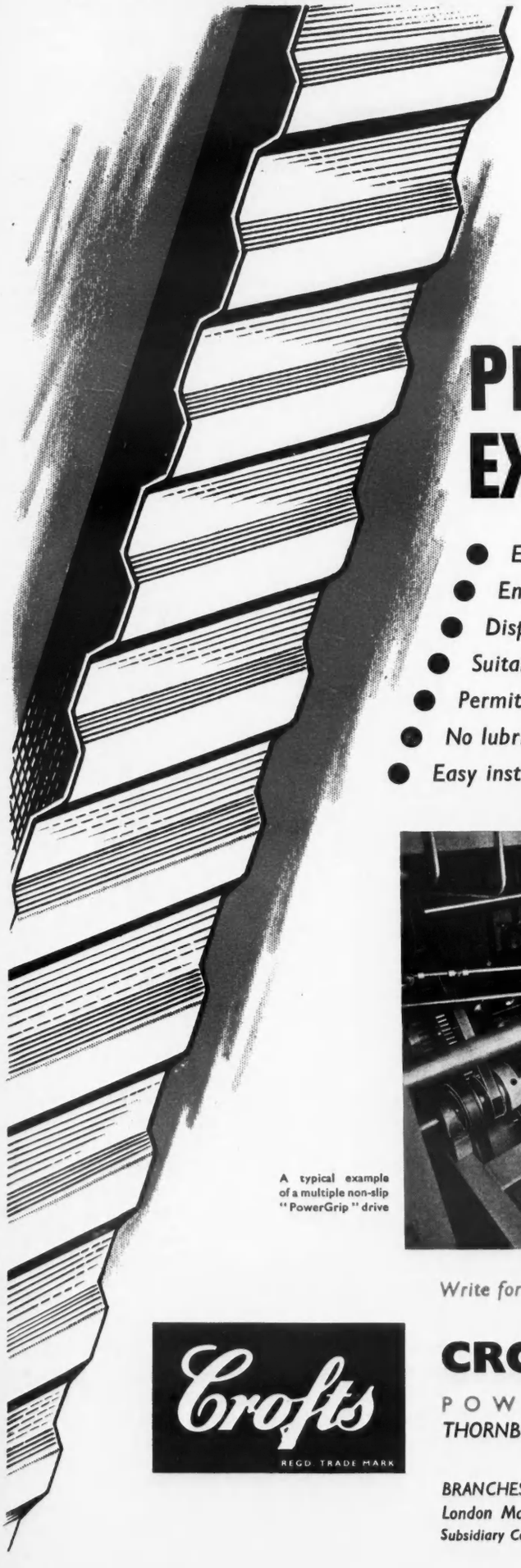


A clean, simple super-

Safe-load indicator for con-



Finger-tip crane controls for fatigue-free handling.



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- *Eliminate slip or power loss*
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- *Dispense with tensioning devices.*
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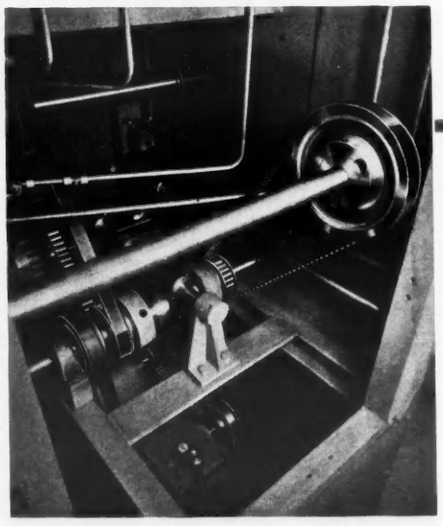

A typical example of a multiple non-slip "PowerGrip" drive

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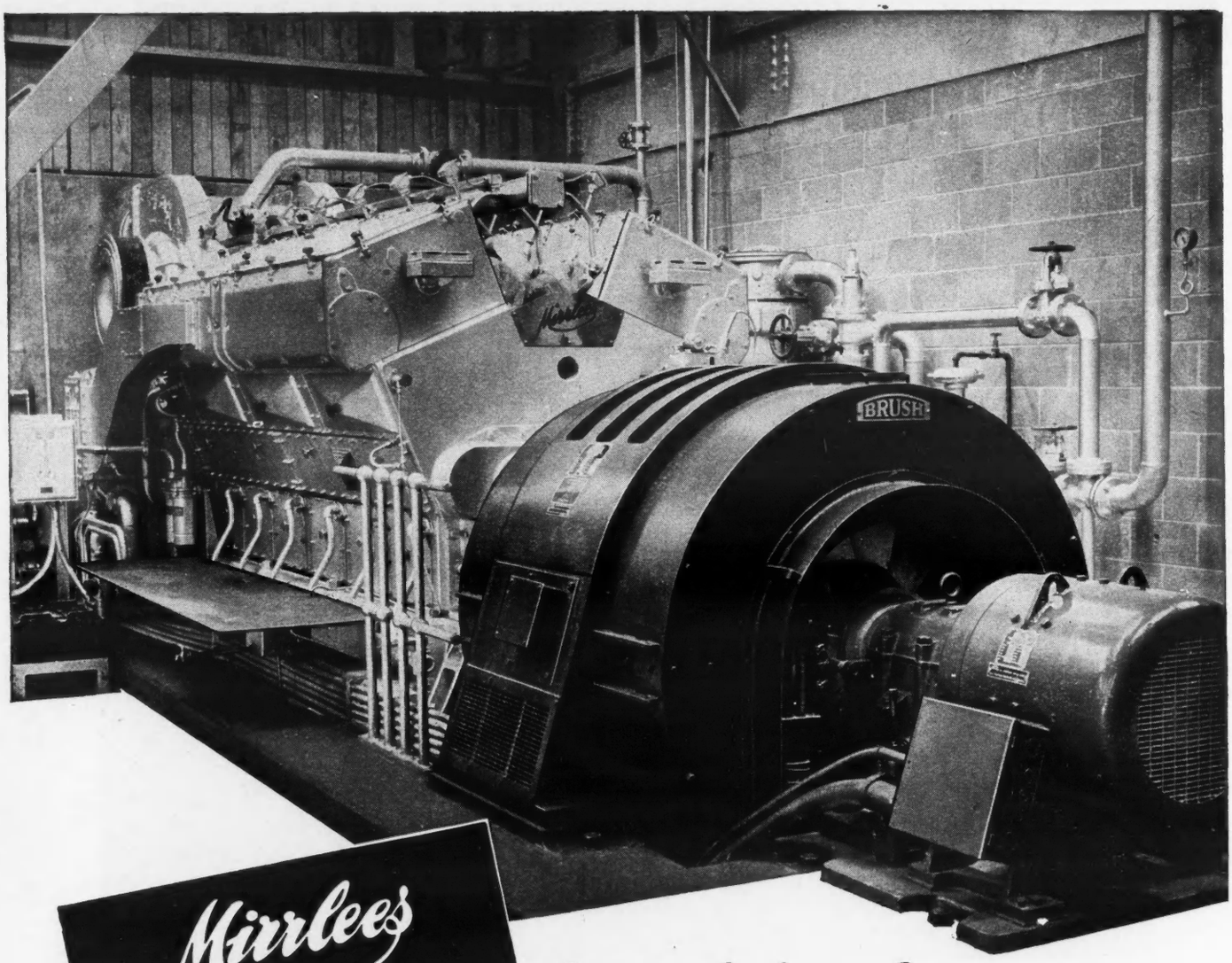


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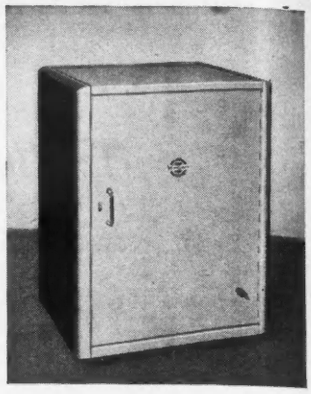

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* *Constructed on unit principle in standard widths*
* *Ample storage space including drawers and shelves*

*Optional extras include:—*
*3" or 5" Vice Paraffin Bath Rack for up to 4 drawers*

These light portable steel benches are constructed on a unit principle in 3 standard sizes 2ft., 3ft. and 4ft. respectively. There is ample storage space inside. They are finished in hammer-tone grey. Optional extras include 3" vice and a vertical rack of up to 4 drawers. The 3ft. and 4ft. sizes can in addition be supplied with a removable paraffin cleaning bath, with sludge trap.

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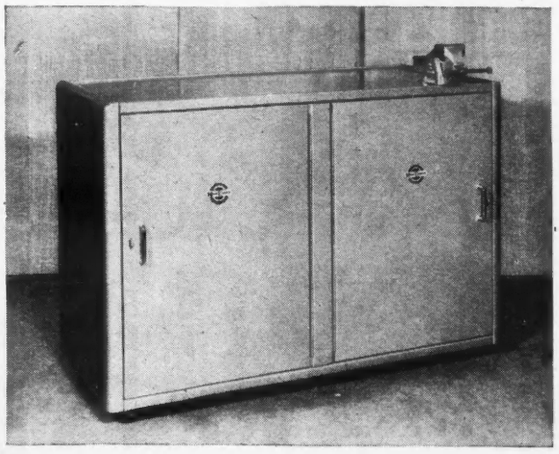

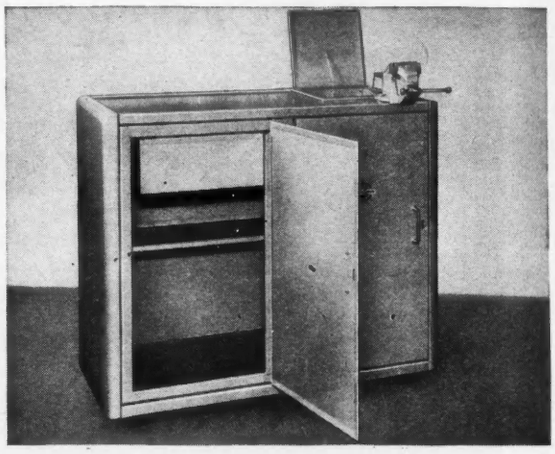

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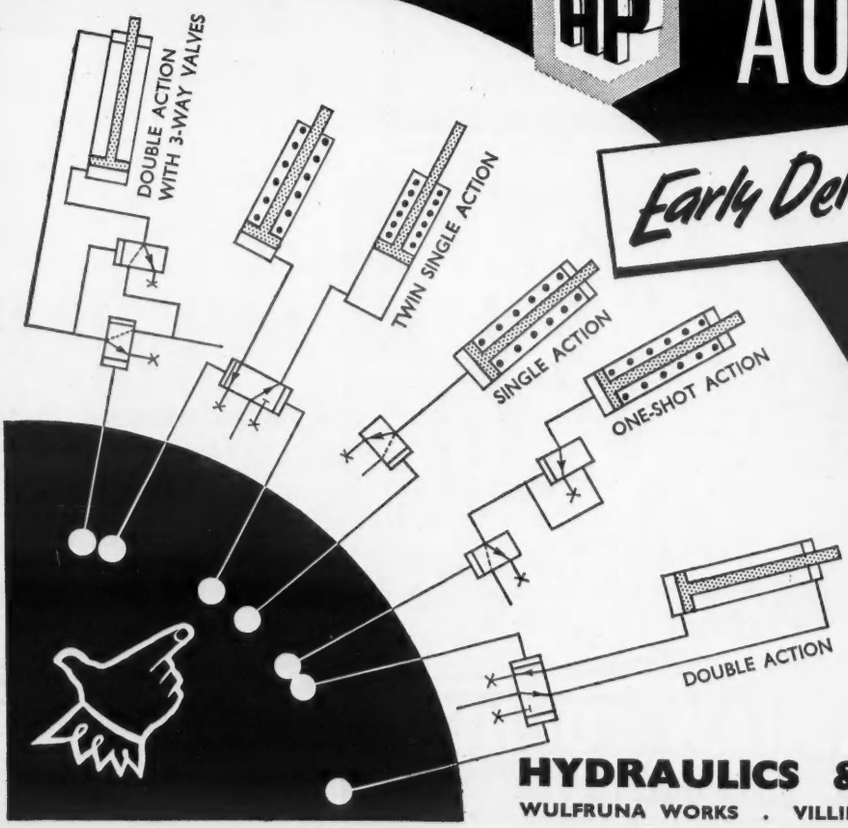


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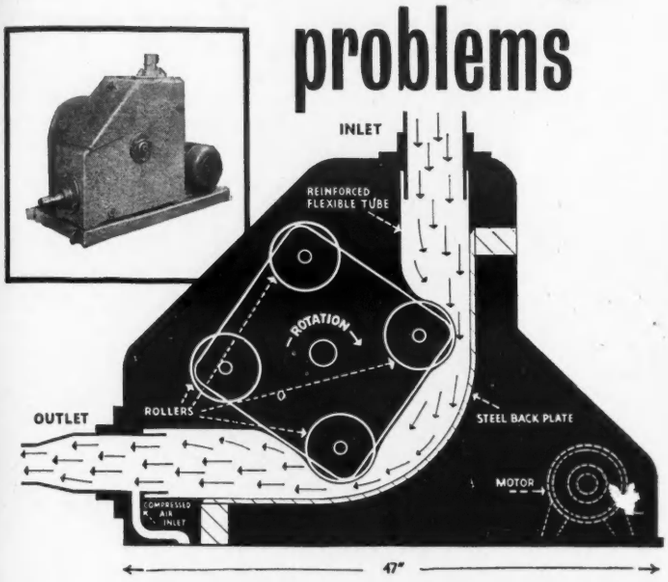


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**2** **Quantities up to 8000 lb. an hour are moved economically.**

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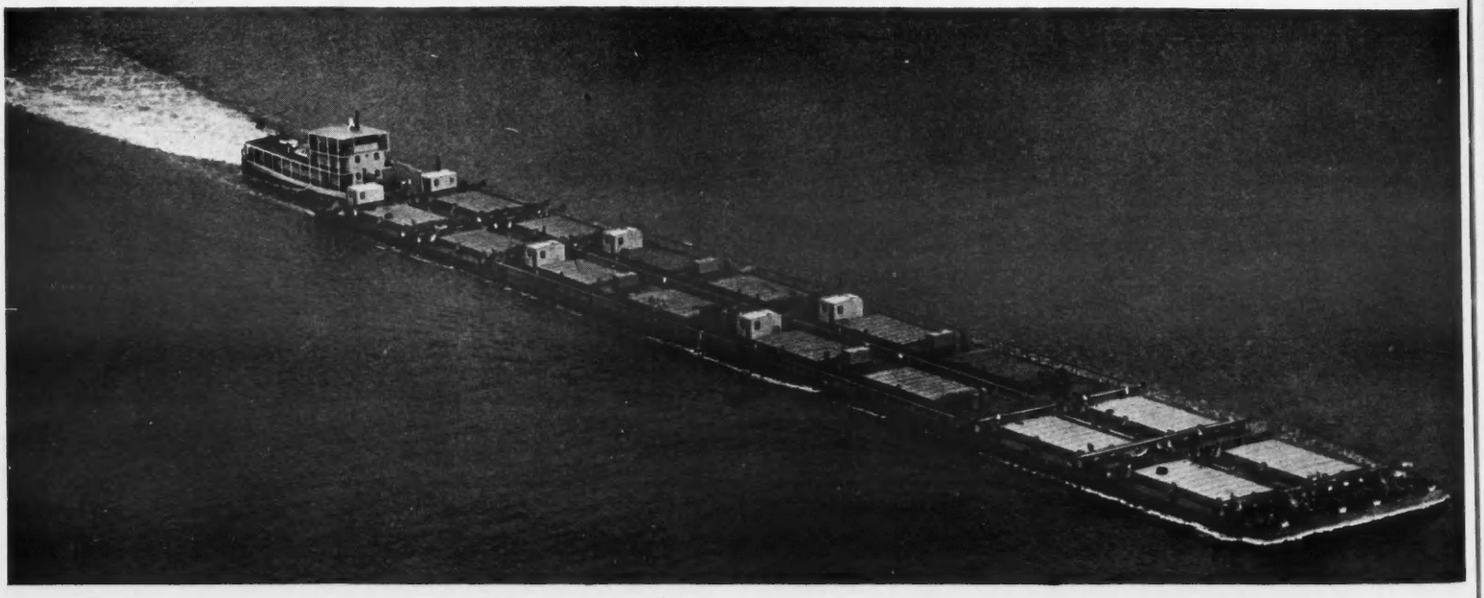
*Loaded displacement 4,650 tons. Overall length 630 feet.*



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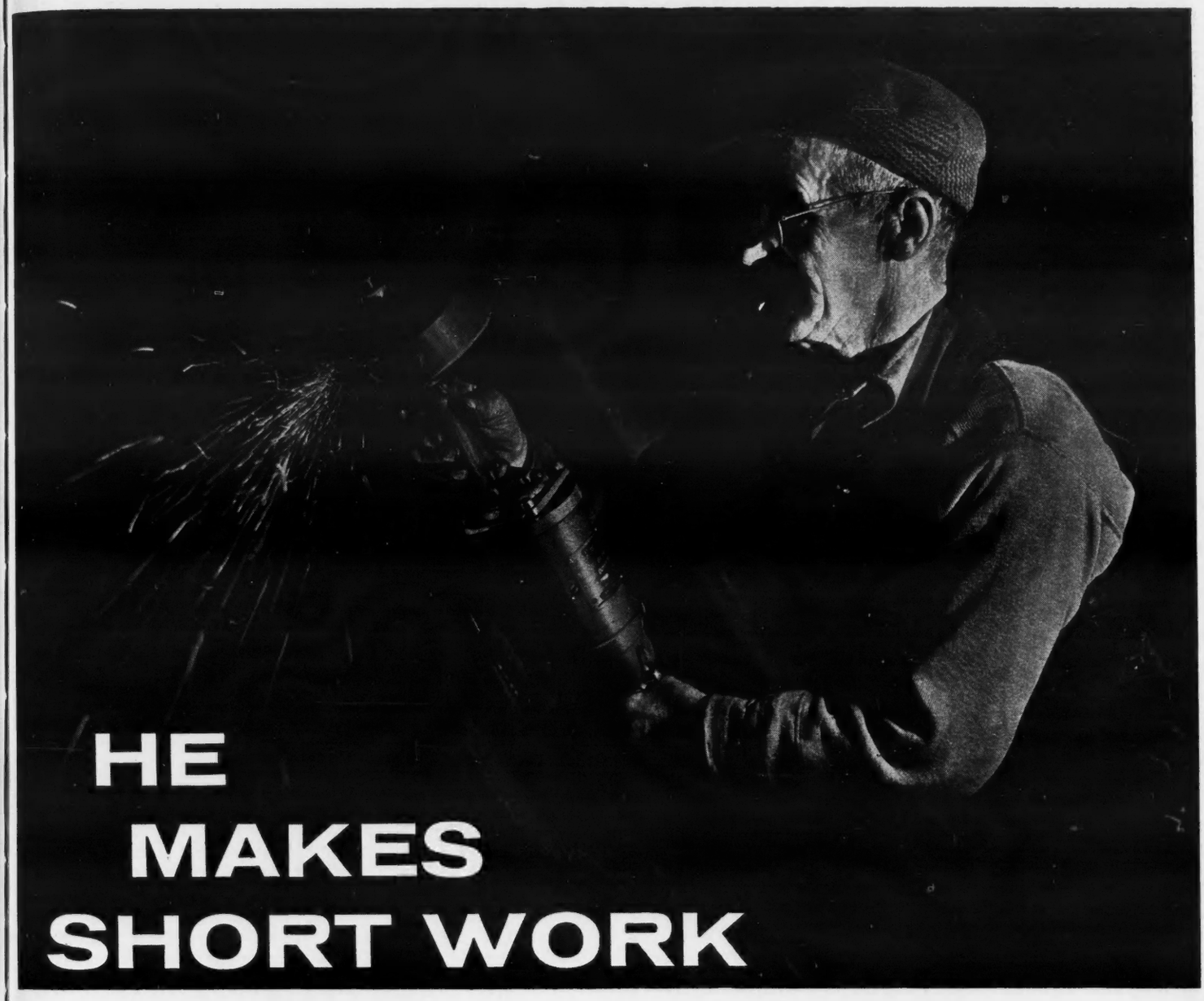

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There is virtually no speed drop under load and faster work is the result. Ask for a catalogue describing the wide range of Hicycle production tools—including angle grinders with cut-off wheels.

Hicycle
electric production tools by
CONSOLIDATED PNEUMATIC

## HICYCLE GRINDING IS FAST...*VERY FAST!*

CONSOLIDATED PNEUMATIC TOOL COMPANY LIMITED · DAWES ROAD · LONDON S.W.6

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# CANTILEVER EFFICIENCY

This is another Mason drafting efficiency development which has been designed to make completely full use of available space and, at the same time, to provide the draughtsman with every desirable and convenient reference, labour, time and space saving facility. The unit provides absolutely rigid support for the drafting stand assembly and is ideally partnered with Arclight reference units. Whether used in large or small assemblies the equipment ensures drafting comfort and freedom of drafting movement with the minimum of physical effort. The Arclight Cantilever Drafting Unit enables the draughtsman to work without the slightest impediment to his legs and feet. The unit has been designed to accommodate a Mason Minor drafting stand with any of several types of drawing board assemblies, according to choice. Also, it has been designed with a view to its use in conjunction with Arclight wood reference tables. The equipment can be used in variously arranged installations, or as a single unit installation in a small office, or as an addition to existing equipment. The inestimable value of this cantilever idea is to be found in its characteristics of providing unrestricted drafting positions, flexibility of arrangement with reference units and filing equipment, attractive appearance and overall cleanliness — a new conception in drafting efficiency.

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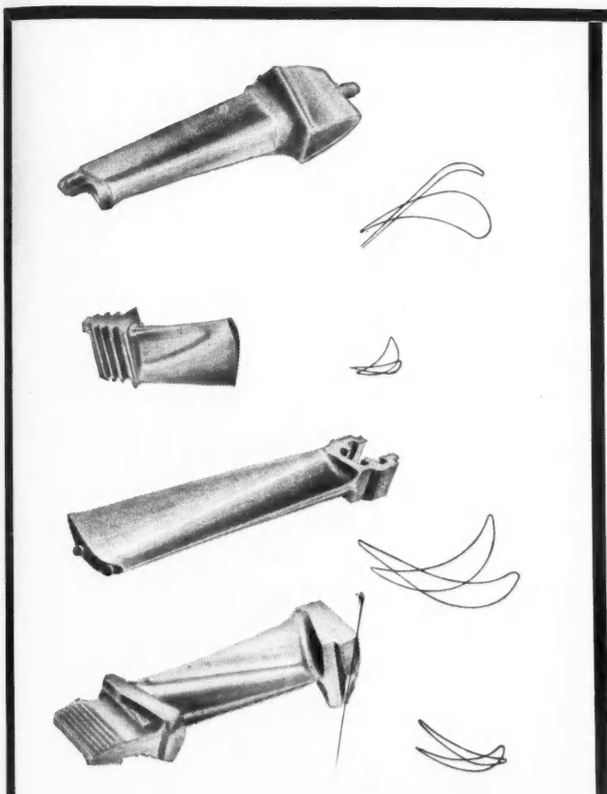

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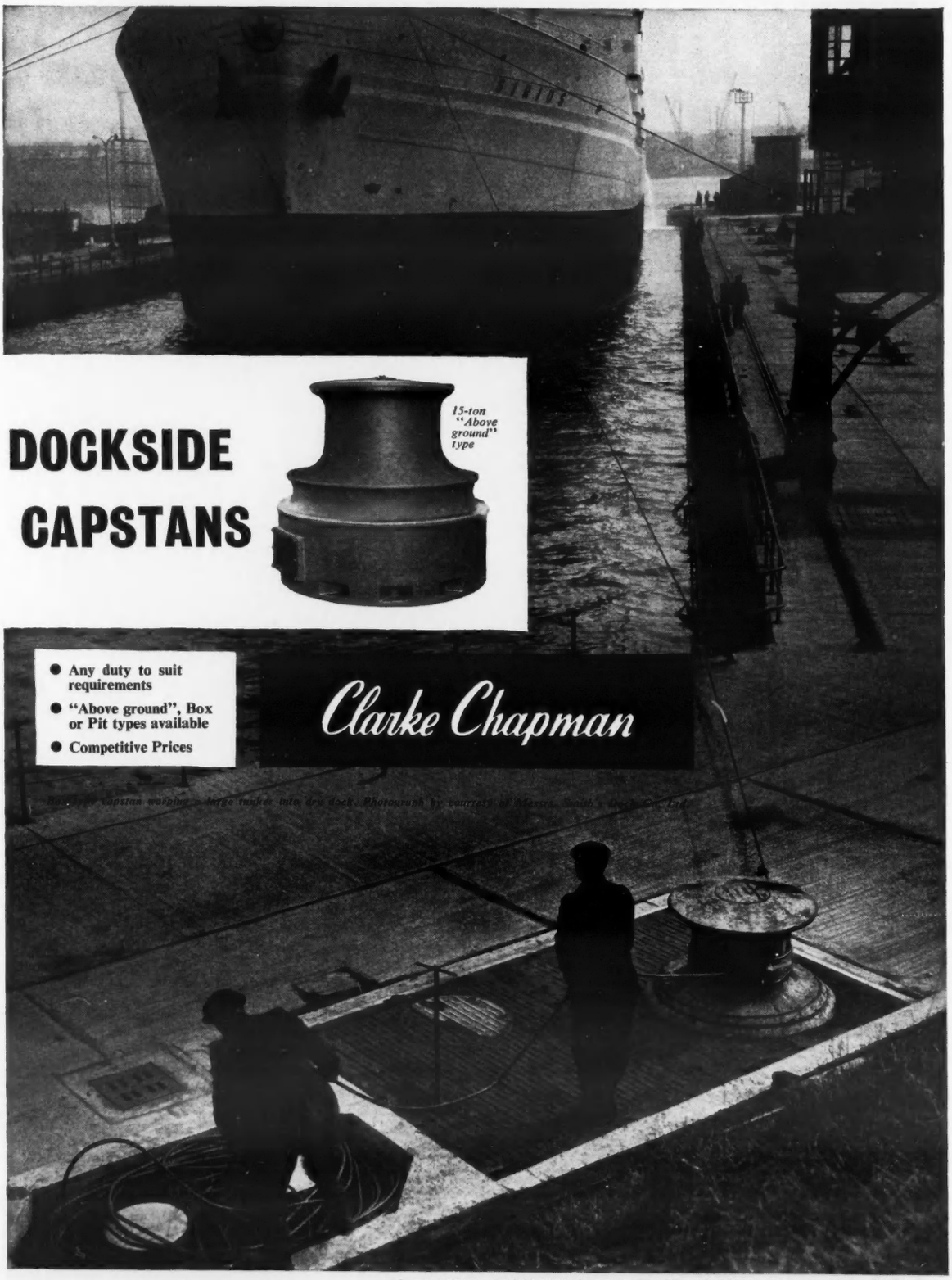


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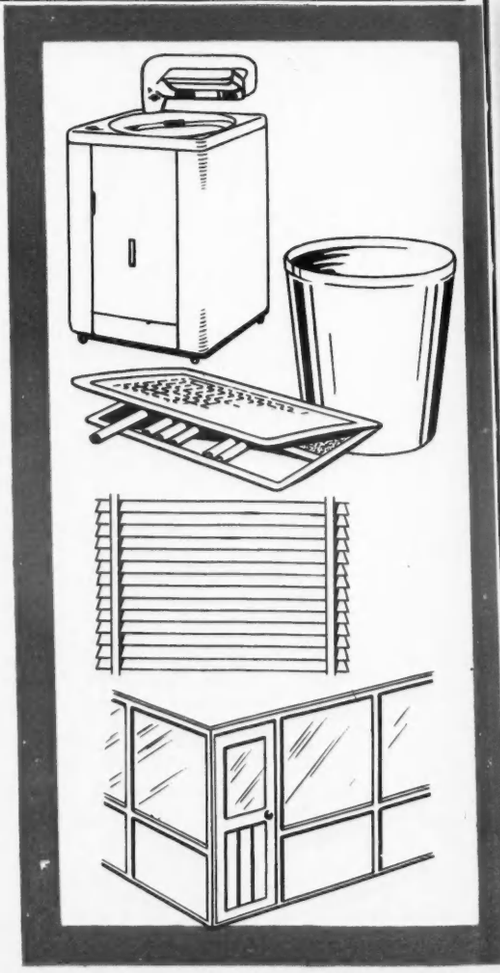

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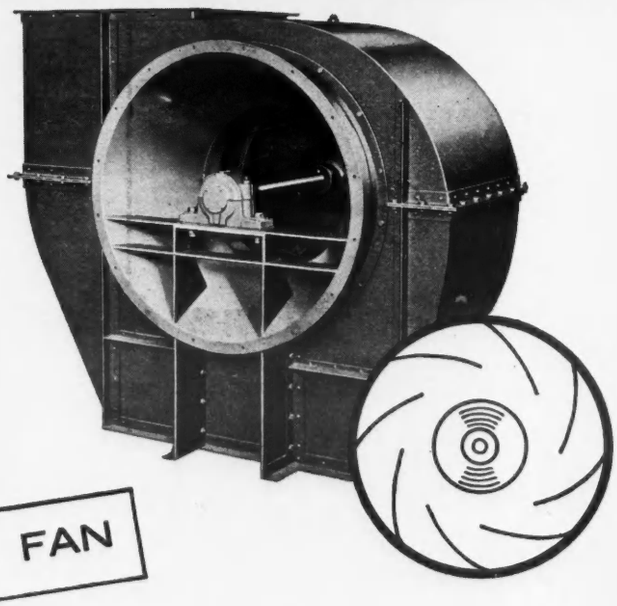

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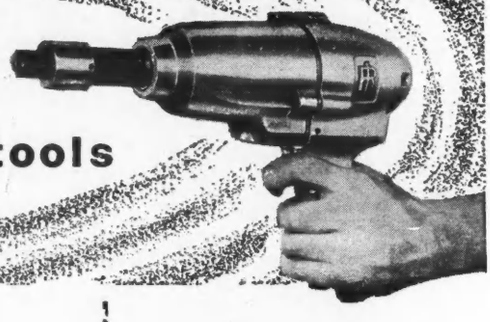
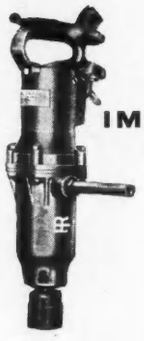
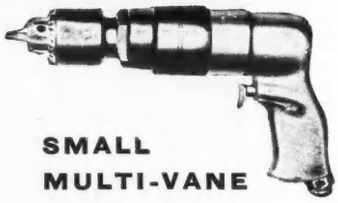




IMPACTOOLS

SCALING HAMMERS



SMALL MULTI-VANE DRILLS

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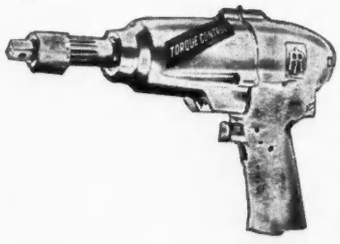
SAND RAMMERS

TORQUE CONTROL IMPACTOOLS



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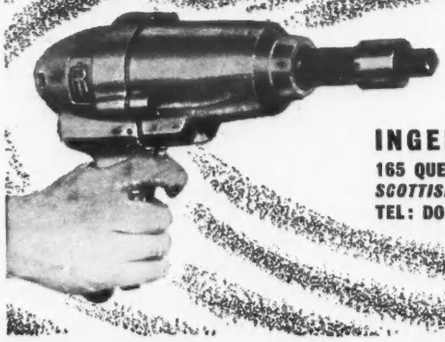

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P.3898

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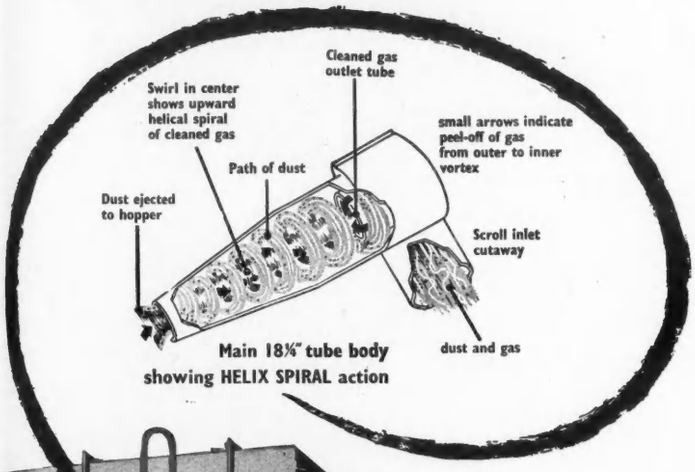
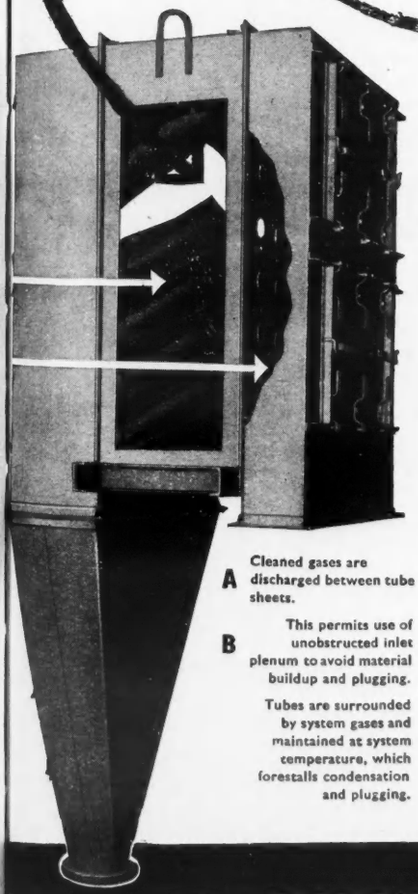

Cleaned gas outlet tube
Swirl in center shows upward helical spiral of cleaned gas
small arrows indicate peel-off of gas from outer to inner vortex
Path of dust
Dust ejected to hopper
Scroll inlet cutaway
dust and gas

Main 18¾" tube body showing HELIX SPIRAL action



A Cleaned gases are discharged between tube sheets.

B This permits use of unobstructed inlet plenum to avoid material buildup and plugging.

Tubes are surrounded by system gases and maintained at system temperature, which forestalls condensation and plugging.

## A REVOLUTIONARY NEW UNIT-CAST DESIGN

This cutaway miniature cyclone tube from the tube bank of the new Mancuna-Dustex Collector shows why efficiency is so high and maintenance negligible. The scroll inlet establishes a velocity which is maintained through its powerful vortex—the dust travelling downward in an outer vortex to the hopper while the cleaned air moves upward in an inner vortex to the outlet tube for discharge between tube sheets. D-584 tubes are available in abrasion-resistant cast iron, non-sparking cast aluminium or stainless steel. Note the one-piece cast tube design with minimum ¼" wall thickness which increases tube life and performance.

## The MANCUNA - DUSTEX D-584 MINIATURE CYCLONE COLLECTOR

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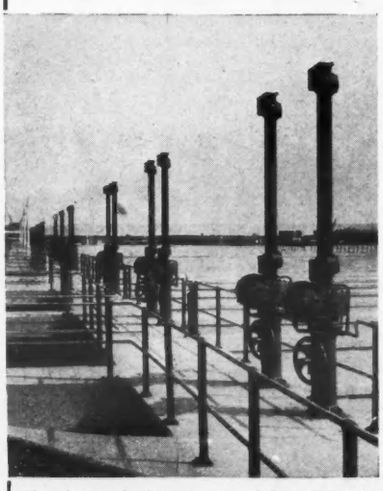
# VALECTRIC REGD.

## VALVE ACTUATORS



*The photograph shows a series of* No. 3 Valectrics *installed at I.C.C. Northern Outfall Sewage Works, Beckton. (Chief Engineer: J. Rawlinson, C.B.E.)*

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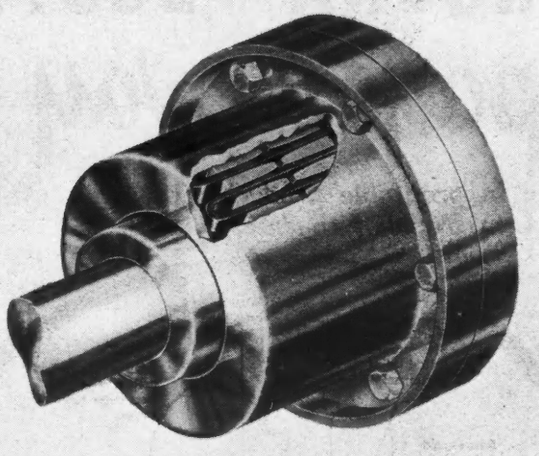

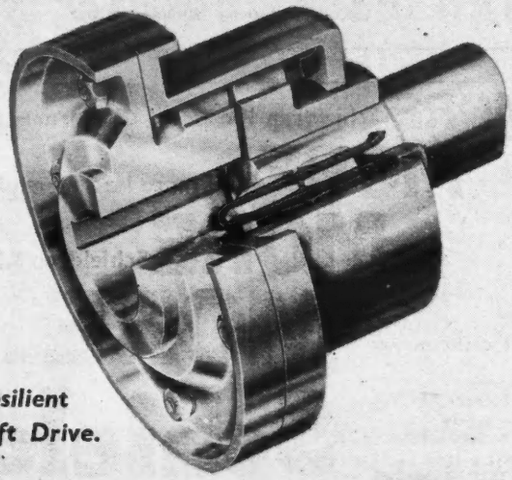

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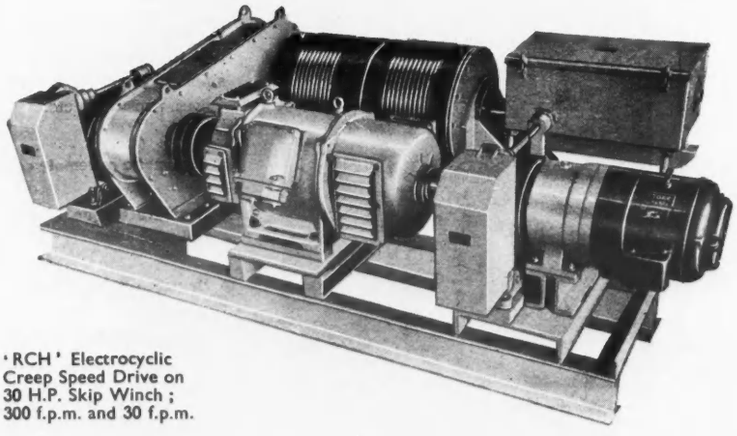

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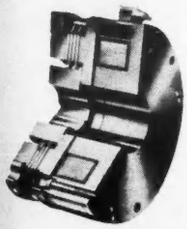
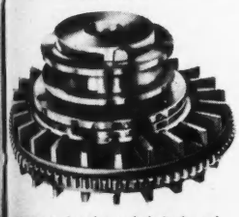


Electro-magnetic, spring loaded brakes



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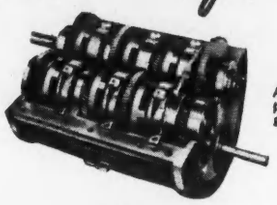
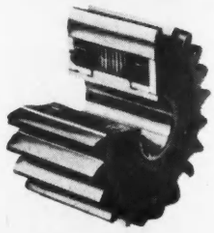
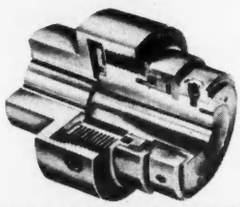


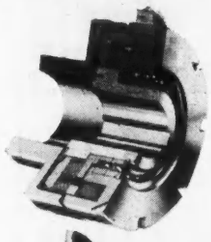
Automatic power shift gearbox



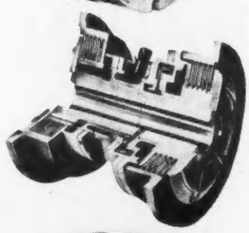
Adjustable slipping clutches



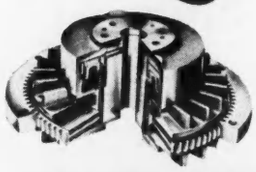
Hydraulic self adjusting multi-disc clutches and brakes



Maintenance-free, slipring-less electro-magnetic 'SINUS' multi-disc clutches



Pneumatic multi-disc clutches and brakes



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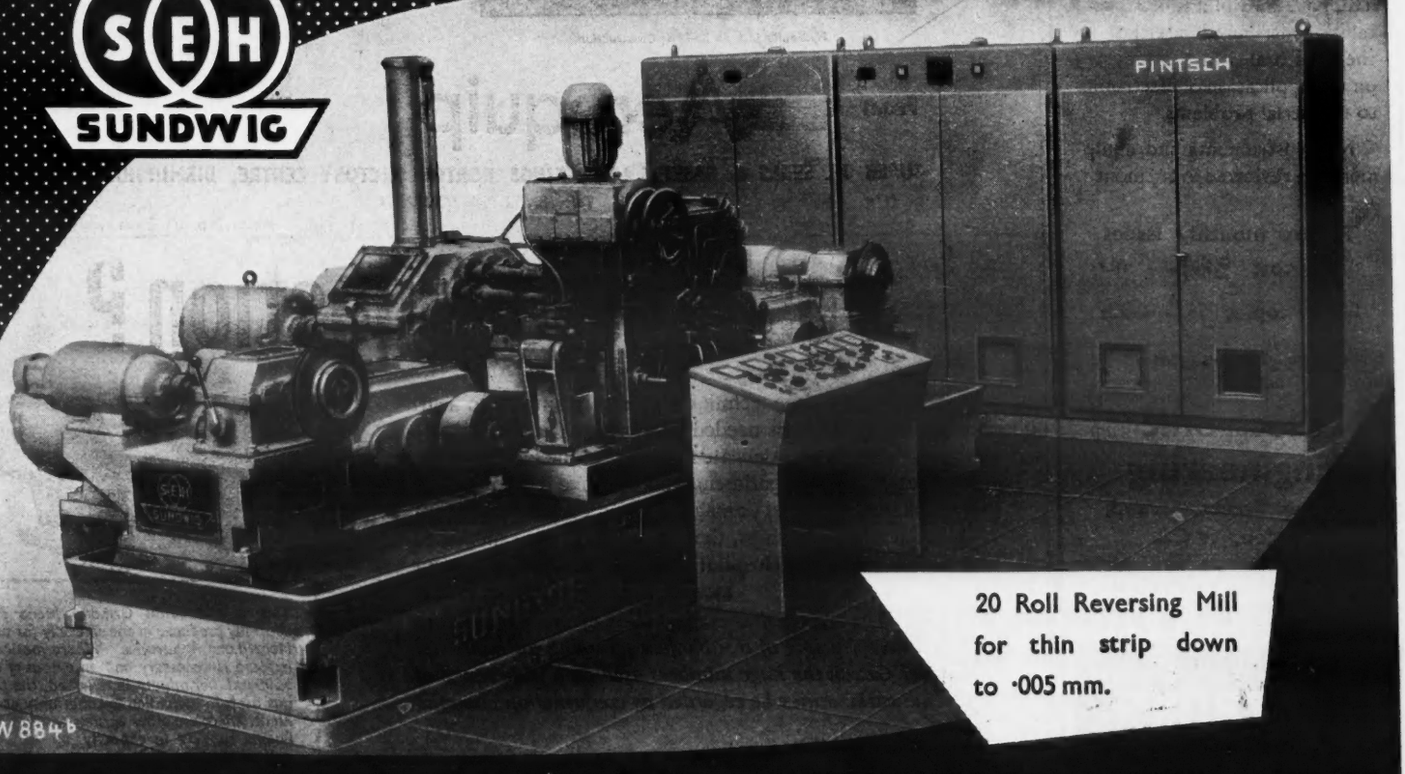


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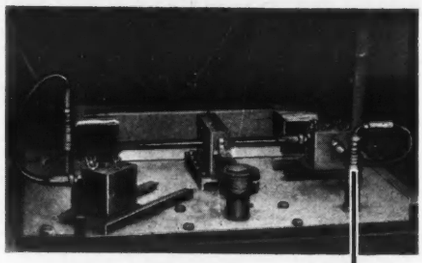
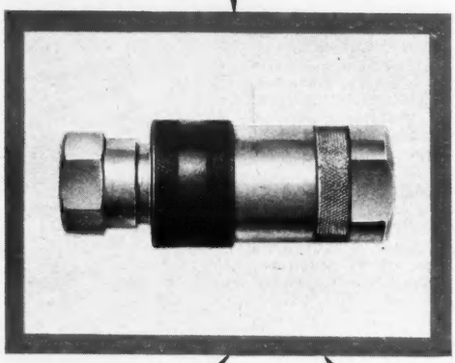


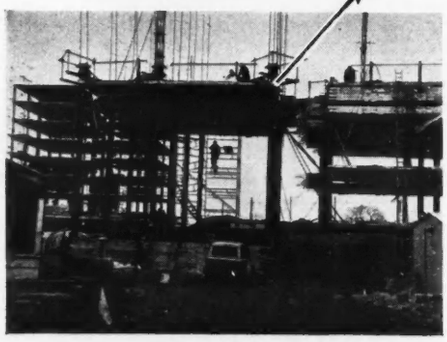
*Experimental Test Labosatory Equipment*

## Goldenflow

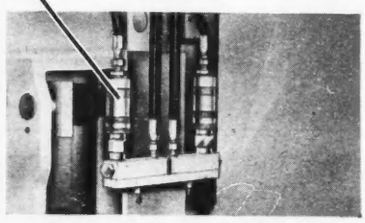
**A New Conception of Hoseline Mobility Saves Time, Money and Trouble**



In the past the only method of connecting Hydraulic feed lines was by screw fittings. Now, with the advent of Golden Flow Couplings, recently introduced by us, a completely efficient connection isac hieved simply by pushing the two halves of the coupling together. Disconnection is effected by pulling them apart. Furthermore, on disconnection each coupling half is automatically sealed by a poppet valve, so preventing the loss of valuable hydraulic fluid. By using a break-away bracket, one half of the coupling is held permanently in place, so that in the event of an unexpected strain on the feed line, the coupling automatically breaks away, without damage to hoseline or equipment.



*Hydraulic Jack on Building Construction*



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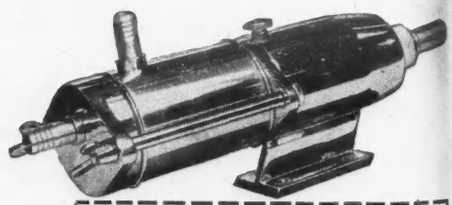
*Can this be regarded as confirmation of the Mono Pump as a superior principle of trouble-free pumping for industrial Service? Or can the huge numbers used on a wide range of industrial duties be regarded as confirmation enough?*



*This is the small Ormond Mono Pump specially produced in one size only for use on Heart/Lung Apparatus. Where meticulous hygiene is necessary and an output of up to 5000 m.l. per minute is required, the pump has useful application to Laboratory or Pilot Plant. There are other various types of Mono Pumps ranging in capacity up to 16000 gallons per hour to cover any pumping duty.*

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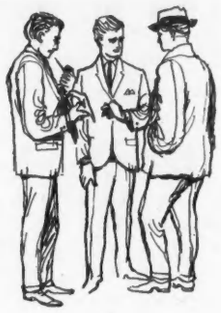

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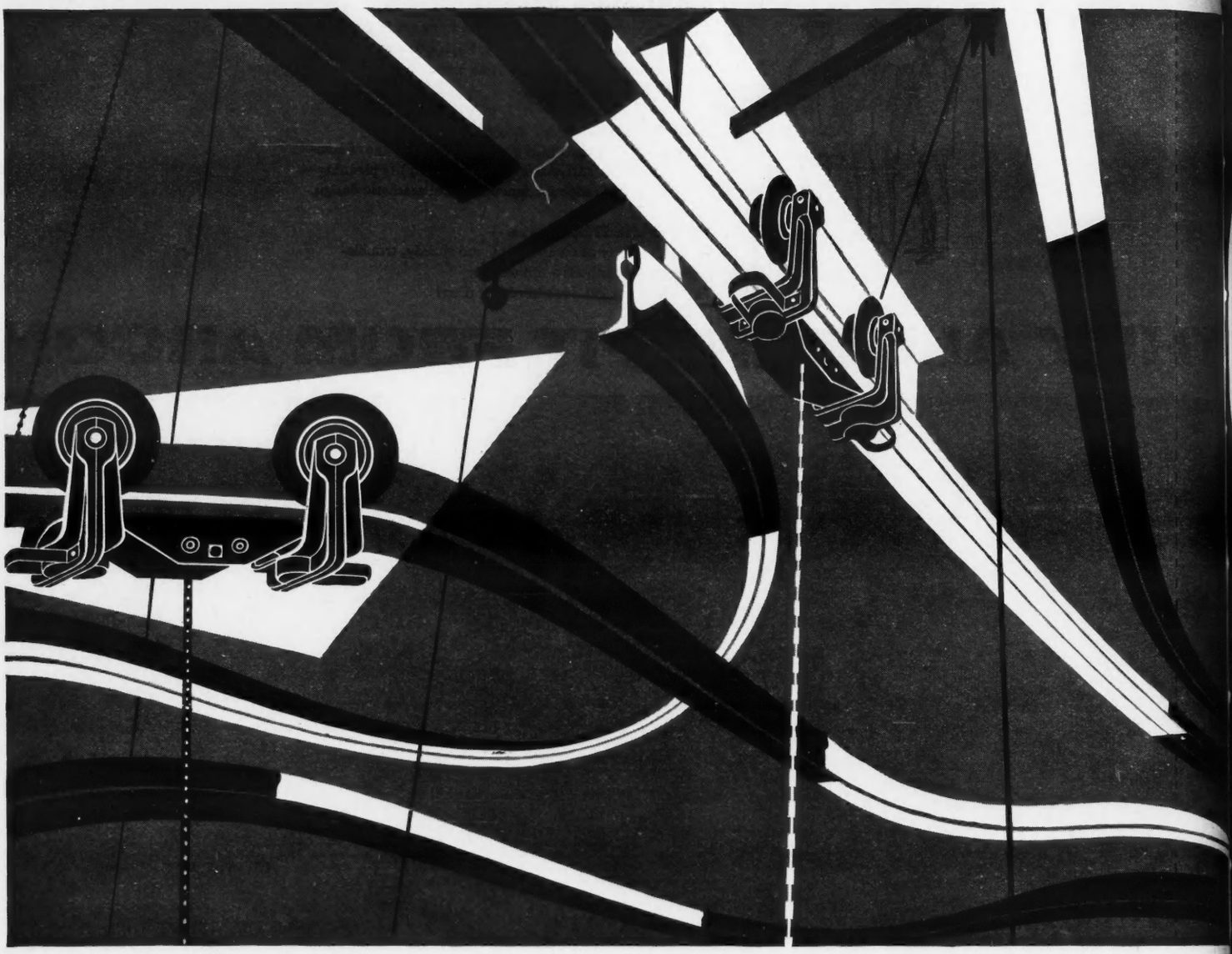
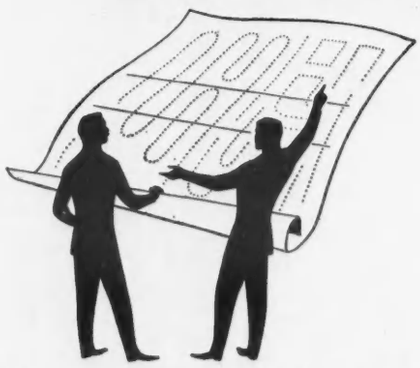


# OVERHEAD is the open road



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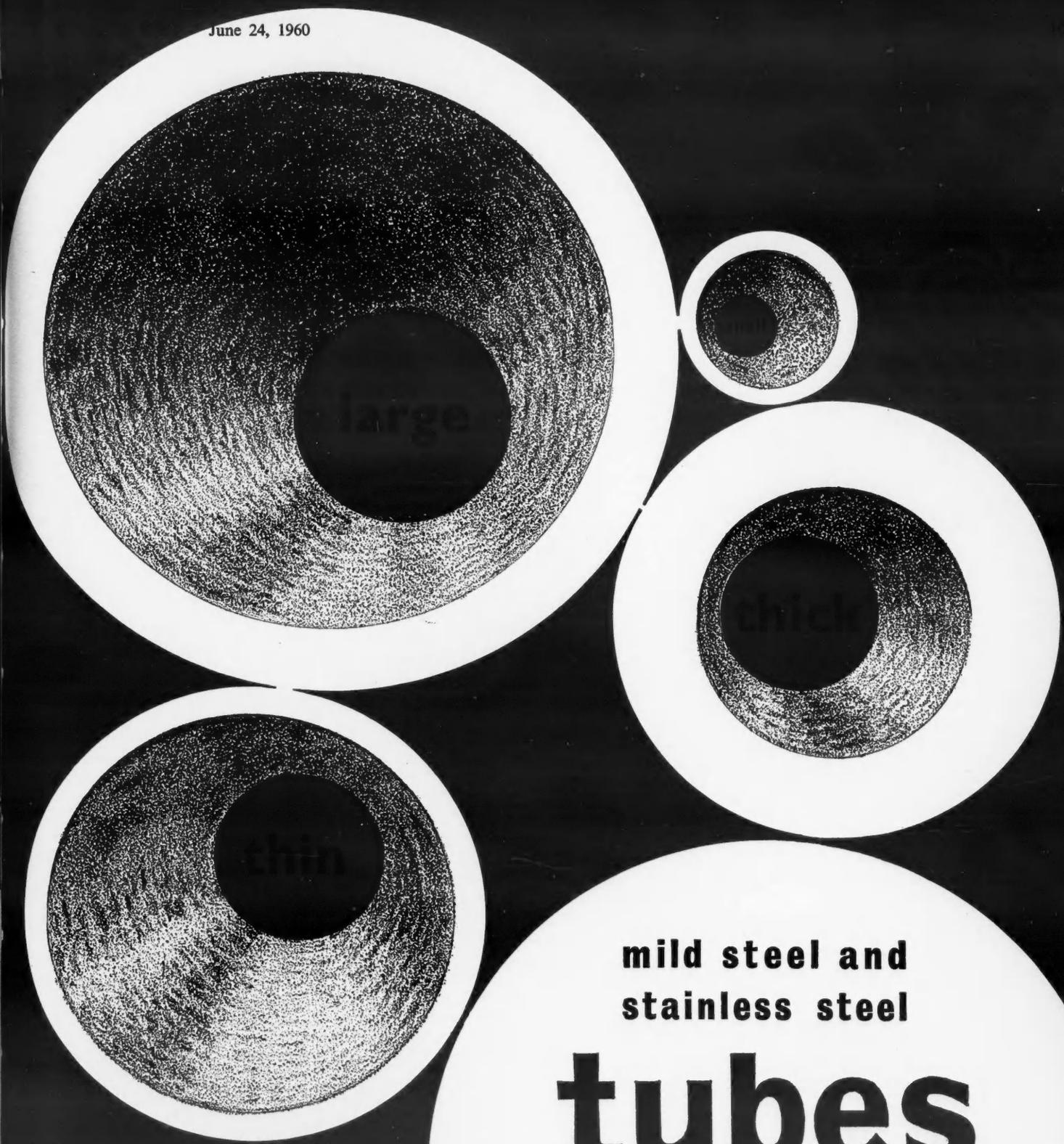


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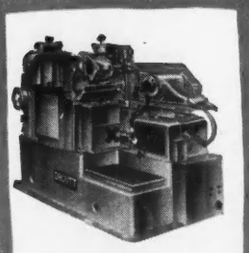
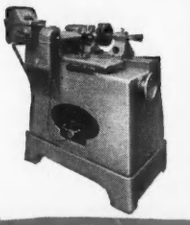
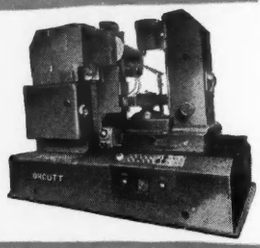


ORCUTT AUTOMATIC GEAR GRINDING MACHINE

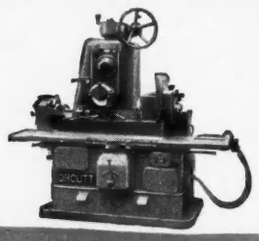
ORCUTT LEAD MEASURING MACHINE



ORCUTT GC 48″ SPUR TOOTH GRINDING MACHINE



ORCUTT 20″ & 36″ HYDRAULIC SHAFT GRINDING MACHINE

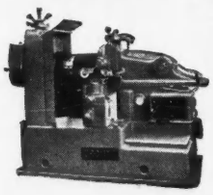


STANDS

The Gear Grinding Co. Ltd.

210-211

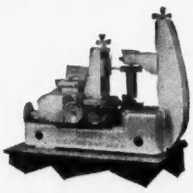
ORCUTT H.M. INTERNAL GEAR GRINDING MACHINE



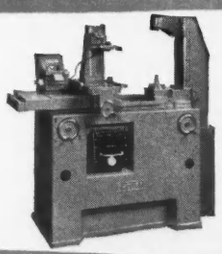
No less than six new machines designed and manufactured by The Gear Grinding Co. Ltd., make their debut on Stands 210 and 211.

Competent technical personnel staff the stand throughout the exhibition and an office for confidential meetings is available on the gallery.

ORCUTT INVOLUTE MEASURING MACHINE Mk III



ORCUTT INVOLUTE MEASURING MACHINE Mk IV



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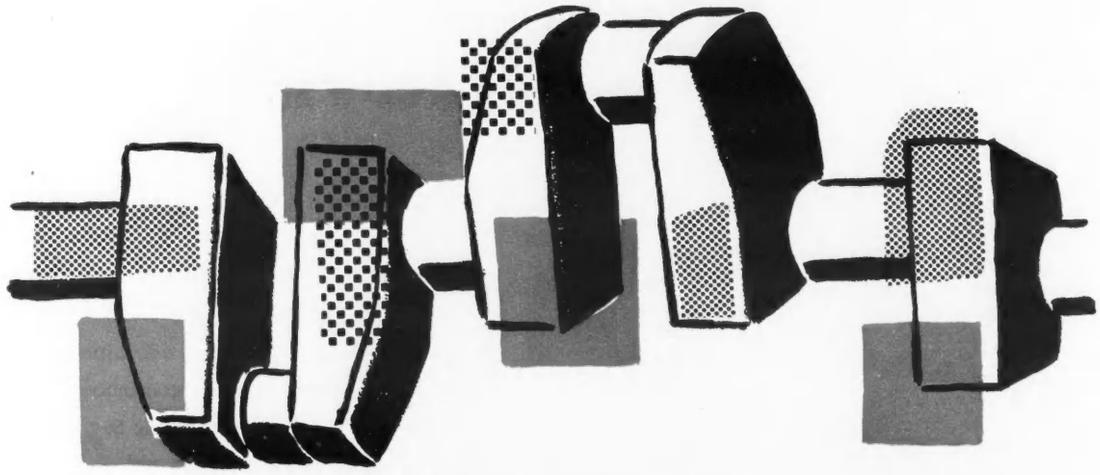
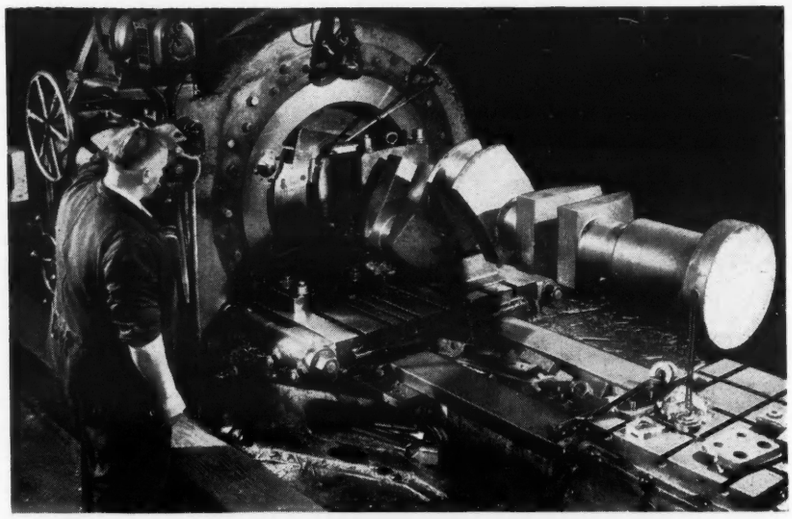


# *Leave it to* LANGLEY



*Photograph shows pins being turned on an auxiliary diesel engine crankshaft*

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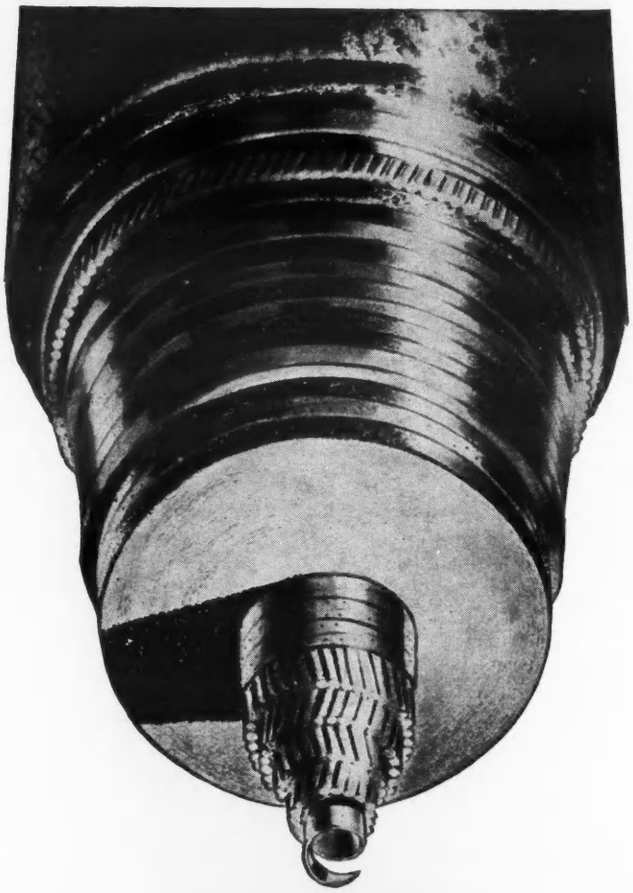

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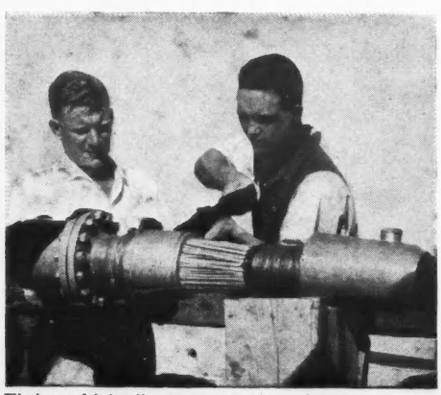
*The Electrical and Mechanical Consulting Engineers: Messrs. Merz & McLellan.*

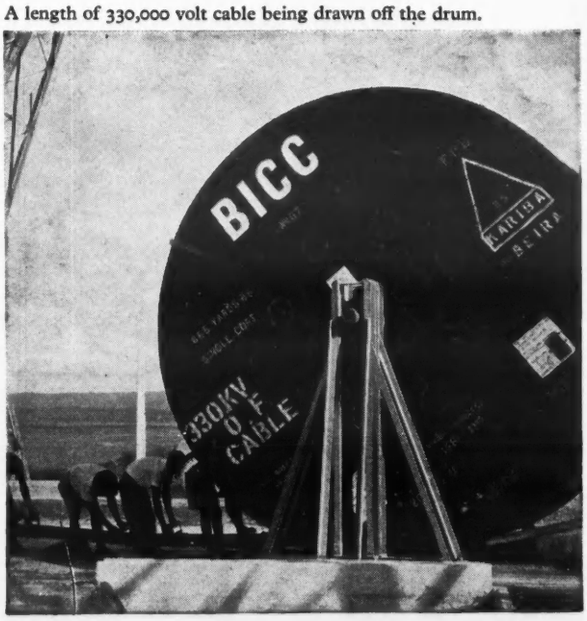
# BICC 330,000 VOLT CABLES AT KARIBA

Installing a 330,000 volt cable termination.
(*Copyright: Federal Power Board*)



Fitting a high oil-pressure cable-end cap.

A length of 330,000 volt cable being drawn off the drum.

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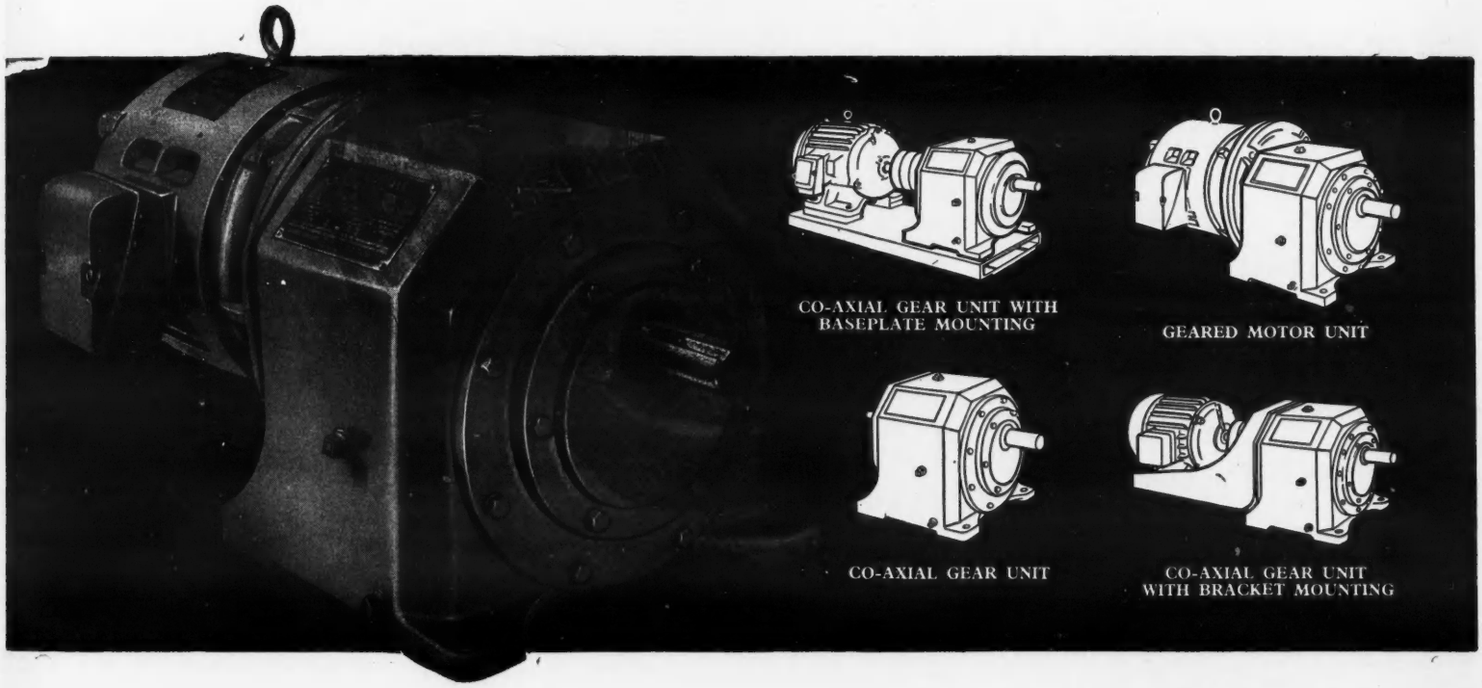
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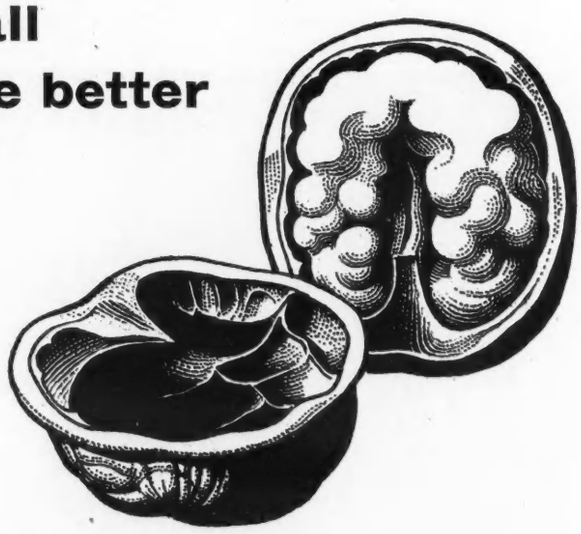

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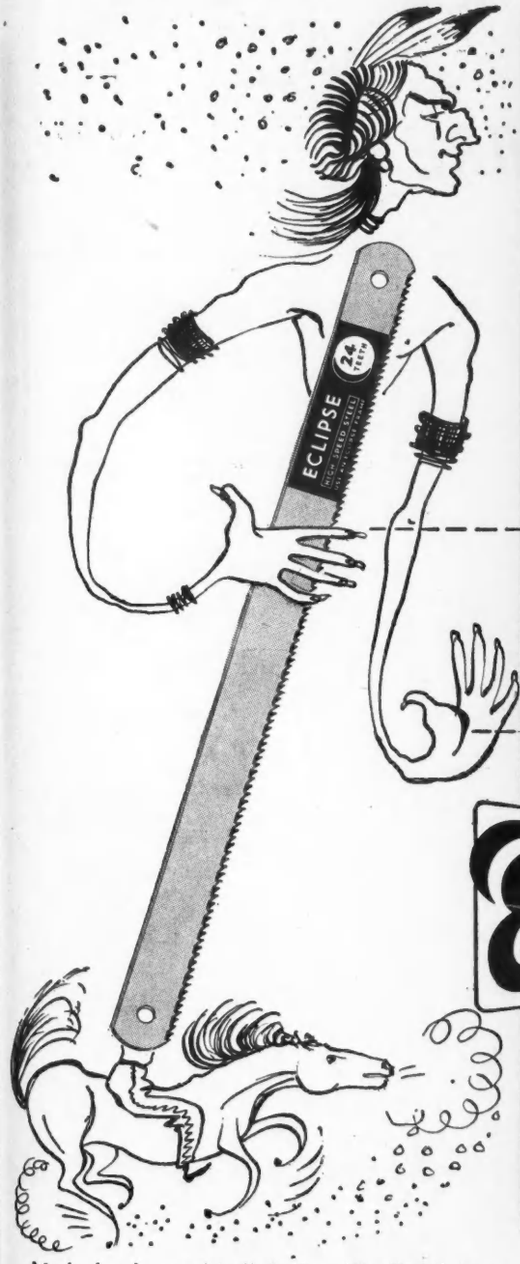


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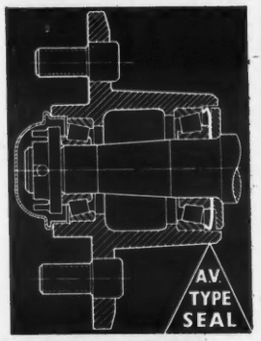


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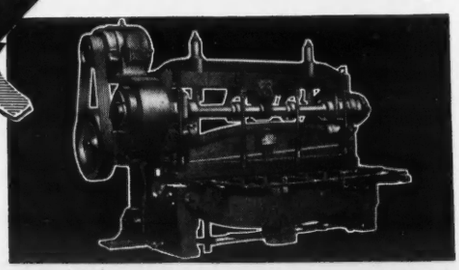

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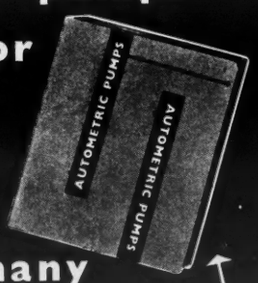


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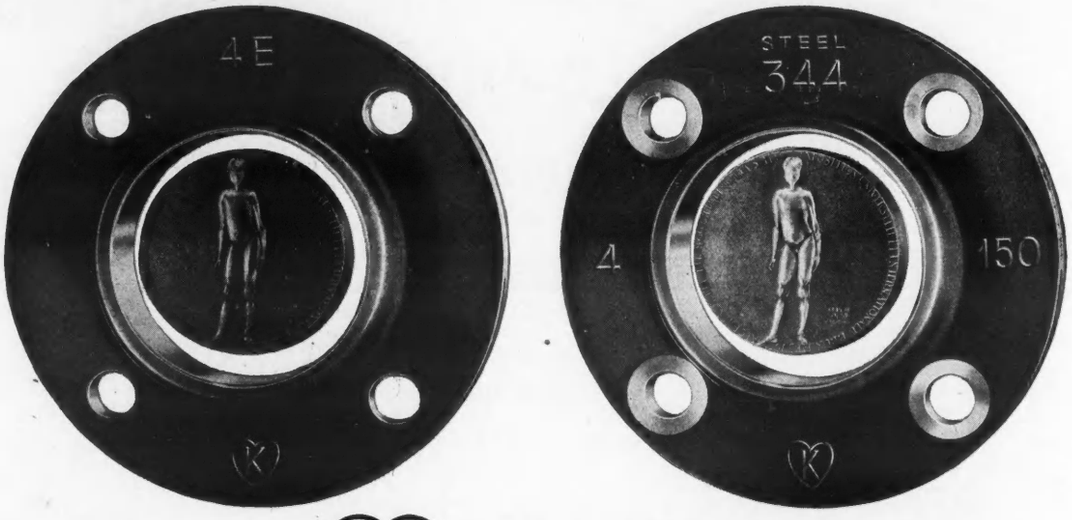


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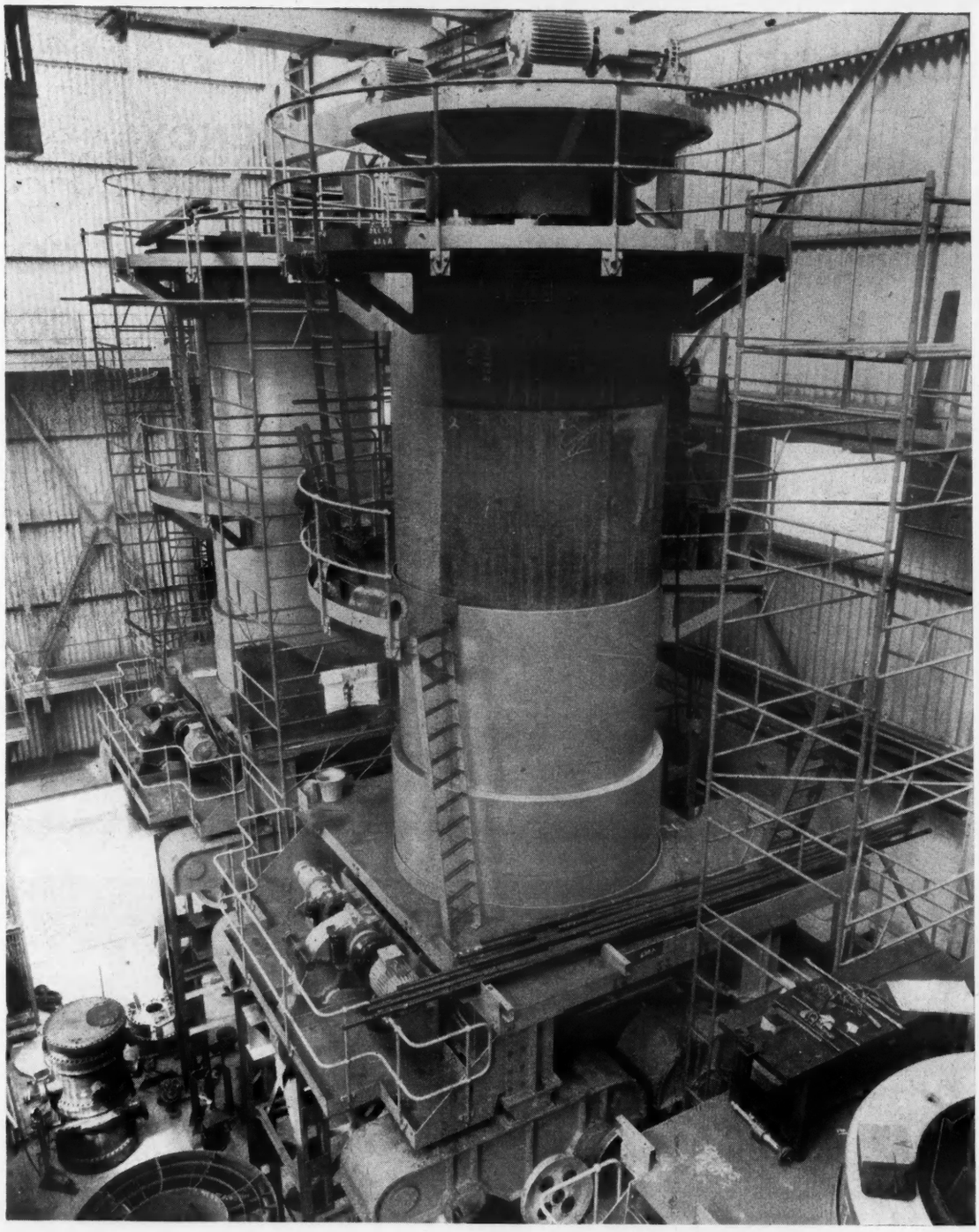

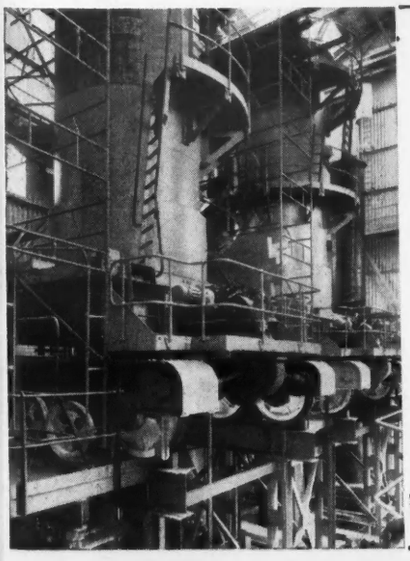

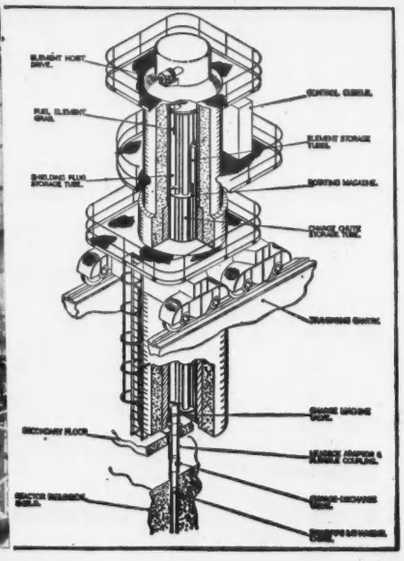

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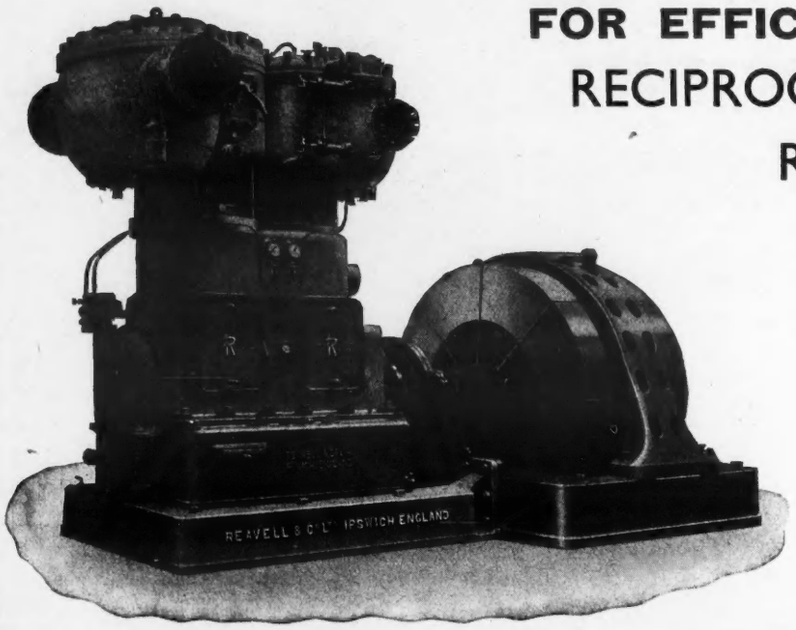


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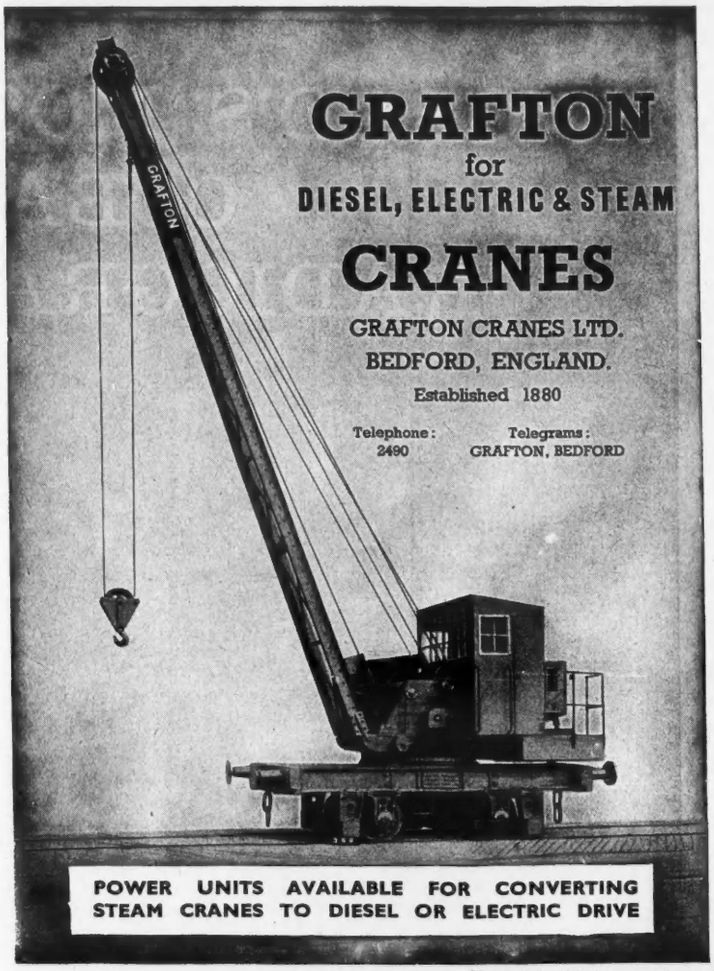


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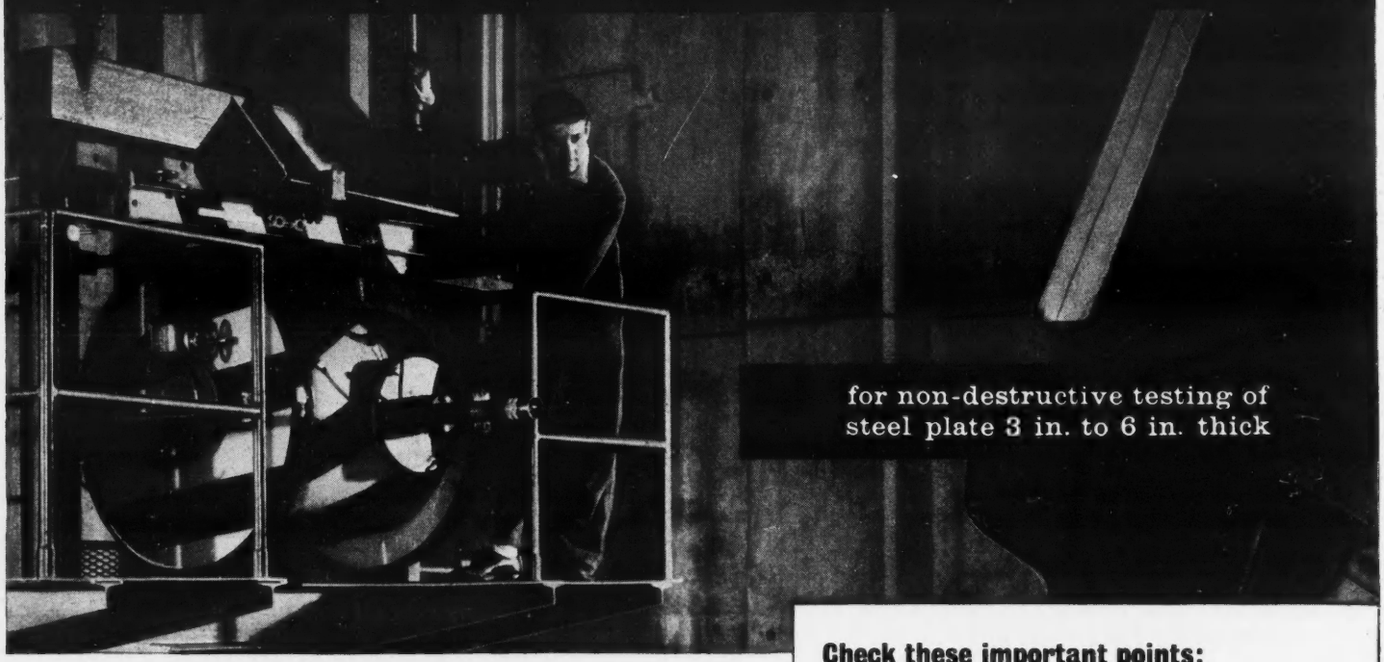

for non-destructive testing of steel plate 3 in. to 6 in. thick

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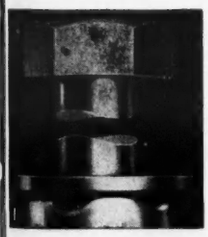
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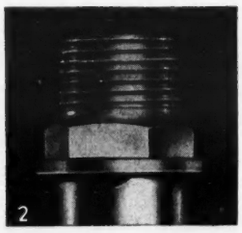
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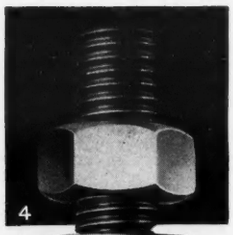
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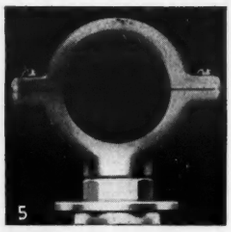
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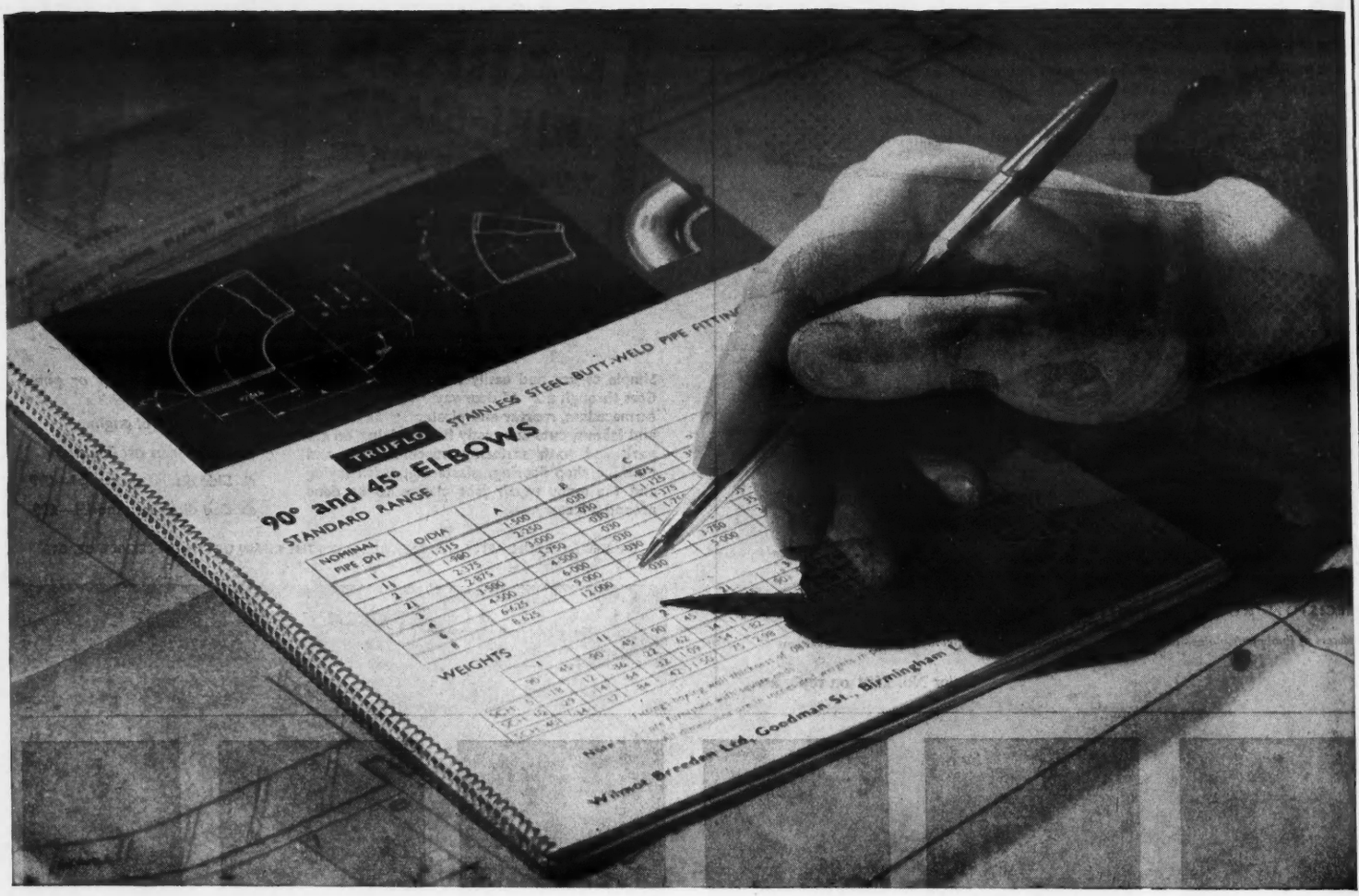

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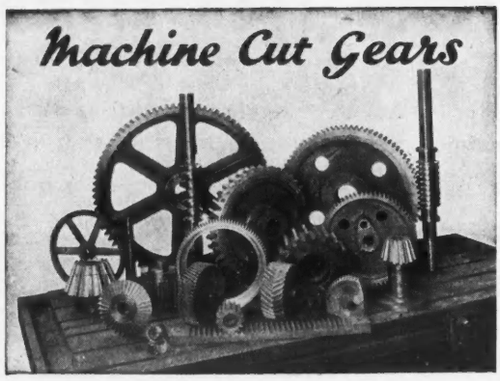

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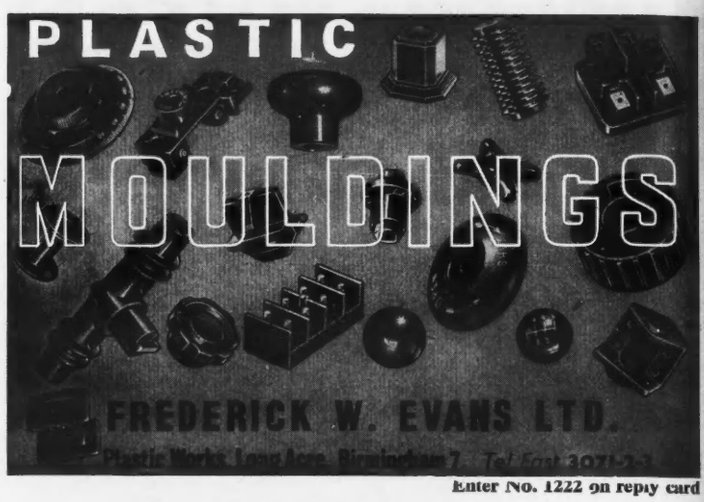

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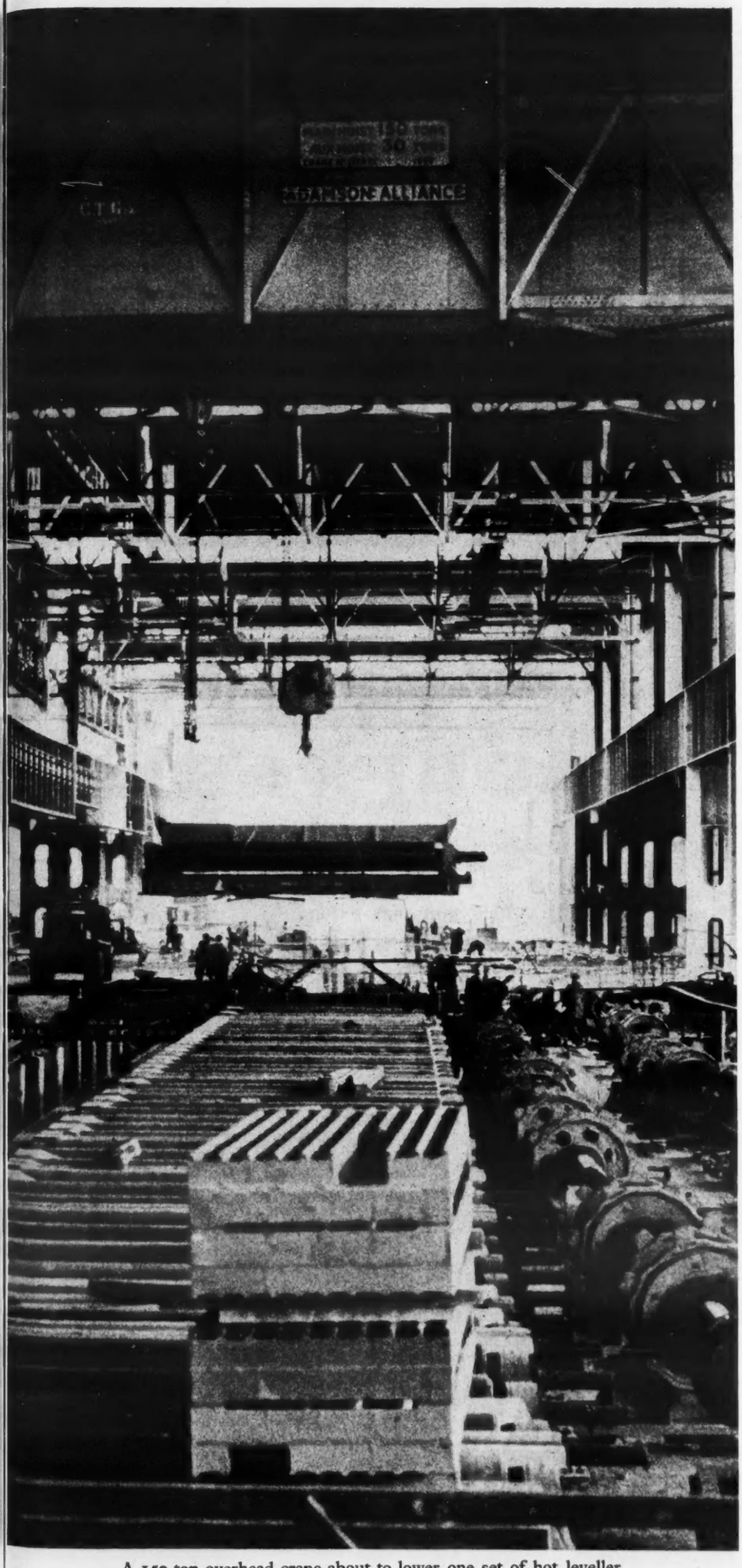

A 150 ton overhead crane about to lower one set of hot leveller run-out table rolls into position. The mill-stand will go at the end of this view. The cooling banks are on the left.

# Britain's latest 4-high Plate Mill

## *A progress report from Consett*

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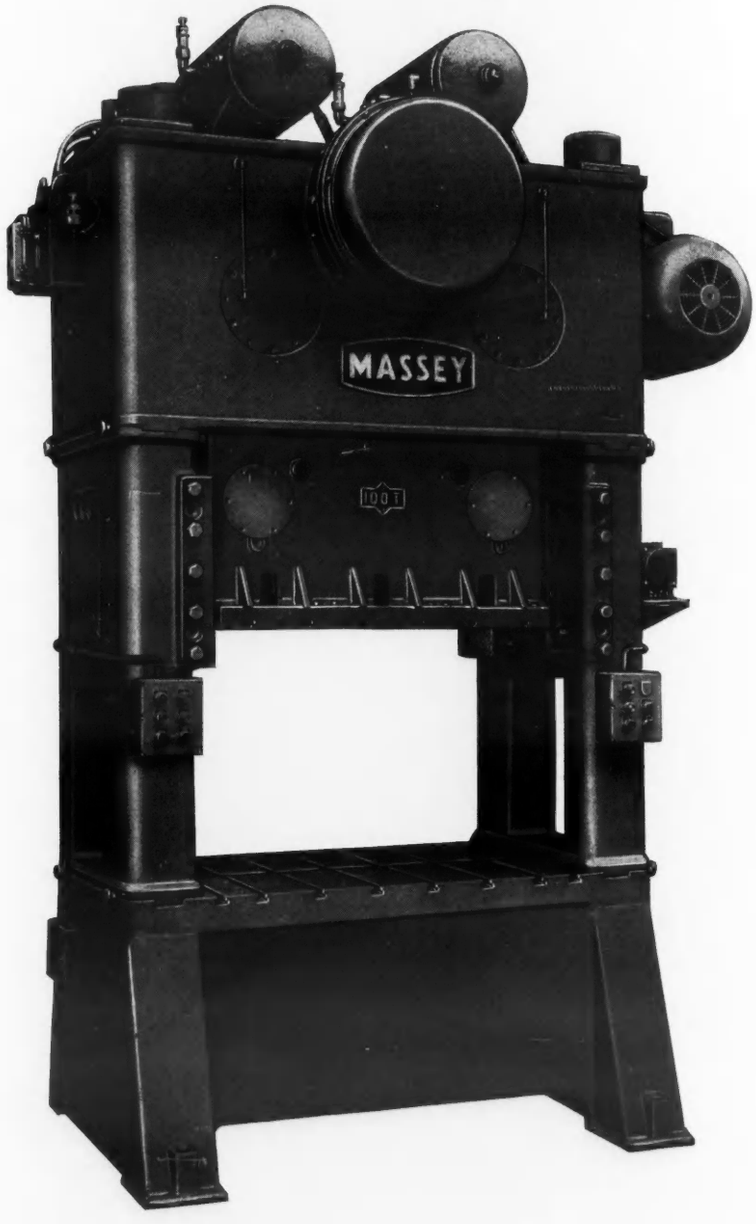


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*100 Ton Wide Ram*
*Trimming and Setting Press.*

***MASSEY DESIGNS INCLUDE:***

*Steam and Compressed Air Hammers, Pneumatic Power Hammers, Friction Drop Hammers, Double-Acting Steam and Compressed Air Drop Hammers, Counterblow Hammers, Forging Presses, Use Rollers, Trimming Presses, Tyre Fixing Rolls.*

**B. & S. MASSEY LTD** OPENSHAW · MANCHESTER · ENGLAND

**MAKERS OF THE WORLD'S GREATEST RANGE OF FORGING AND DROP FORGING PLANT.**

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# and NOW . . .

*the Super*
# POLYBLOC
TRADE MARK

*The most efficient*
**GRAPHITE HEAT EXCHANGER** *in the world*

**for heating or cooling corrosive fluids**

*Only the Super* **POLYBLOC** *has all these features . . .*

- ★ Constructed from Graphite monolithic blocks of high thermal conductivity.
- ★ No tubes—no cement joints—no heat transfer barriers.
- ★ Remarkably high heat exchange efficiency.
- ★ Minimum film and scale formation.
- ★ All components consist of standardised interchangeable units. Assembly can be adjusted to accomodate infinite number of process requirements.

THE SIGN OF GOOD WELDING

IVANHOE

ROBERT JENKINS & CO. LIMITED ROTHERHAM
Telephone: 4201-6 (6 lines)

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~~64~~

# NOW 68

**different holders and 306 varieties of inserts for negative and positive cutting now available**

- heat treated alloy steel holder — 50 HRc.
- chipbreaker lifts automatically — can't fall out when tip is changed or indexed.
- perfect stability — tip recess direct in solid shank.
- unobstructed chip flow — no protruding parts.
- two or more holders easily clamped together.

Coromant T-MAX

THROW-AWAY HOLDERS & INSERTS

*slash production costs*

*Send for Booklet E-542, 4E.*

SANDVIK SWEDISH STEELS LTD. HALESOWEN BIRMINGHAM

*Telephone: Halesowen 2121 (7 lines)*

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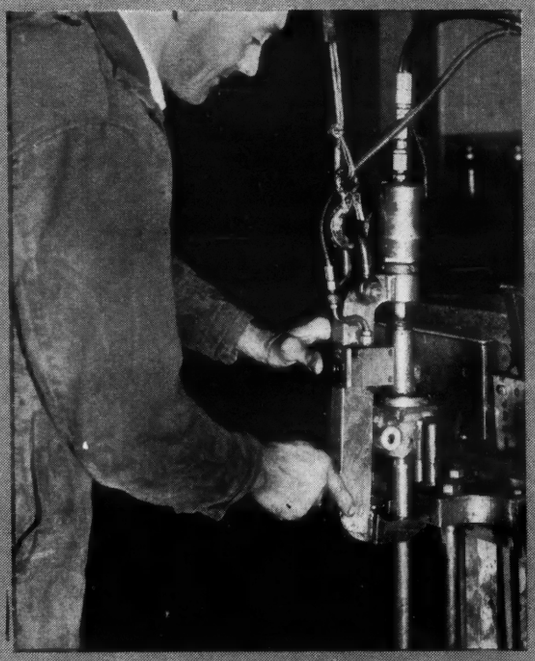
"BROOMWADE" HYDRO-PNEUMATIC SQUEEZE RIVETERS have been the means of overcoming numerous riveting and punching problems which previously were considered almost impossible. Perfect rivet formation can be attained in the most restricted places, and enormous power can be concentrated in a small hand-held tool.

*"BROOMWADE" Type HPS15 Squeeze Riveter.*
*Riveting over a Nylon bearing bush to a ball selector peg during the assembly of the Standard 6-cwt. Van Gearbox.*

An intensifier having a large compressed air operated piston exerts its total load on a small hydraulic ram mounted in tandem. The resultant hydraulic pressure is from 30 to 60 times greater than the air pressure used, and is transmitted to a small operating cylinder on the riveting yoke. This operating cylinder can be applied to any type of yoke, hand held, bench mounted, or floor mounted. Control of the unit can be either by foot pedal operated valve, or by remote push button.

A world-wide service organisation is available and expert advice from works-trained technical representatives.

*Write for full details.*



*"BROOMWADE" Type HPS5 Squeeze Riveter with push button control in use during the assembly of the inner rear hub and outer bearings to the axles shaft of the Triumph Herald.*

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AIR COMPRESSORS & PNEUMATIC TOOLS
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761SAS

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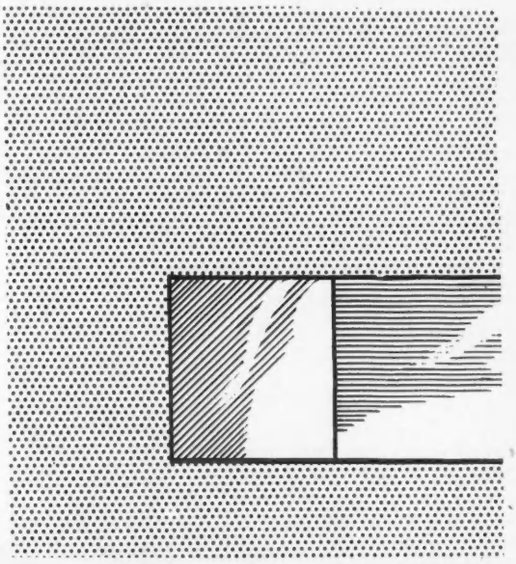

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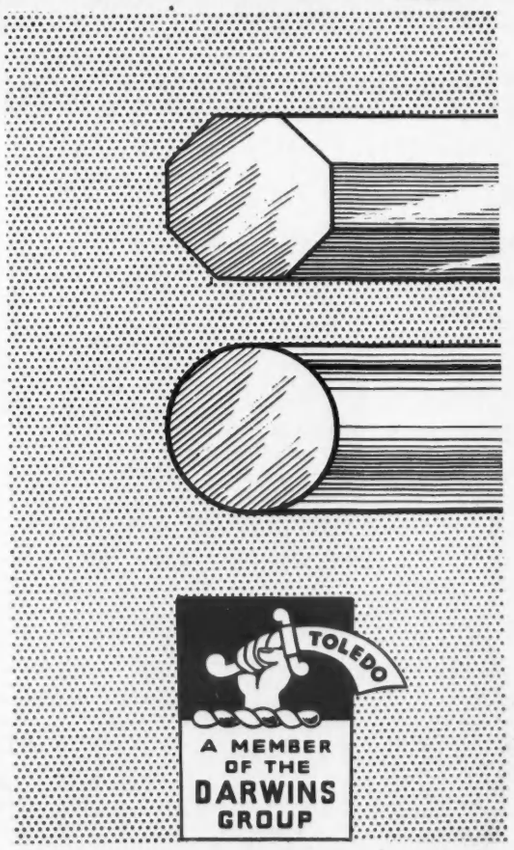
## DRAWN · TURNED · GROUND




**AVAILABLE IN A LARGE RANGE OF QUALITIES AND SIZES**

HEXAGONS 3″ A/F to ¼″ A/F
ROUNDS 3½″ to 3/32″
} Dependent on quality and treatment

SQUARES 2⅝″ to ¼″ FLATS 3″ x 2″ to ½″ x ⅛″

## DARWINS BRIGHT STEELS LTD.

SHEFFIELD

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Q

BRITISH RAILWAYS

# Diesel Electric Pullman Trains

*BUILT BY*

METRO-CAMMELL

*For*

*THE PULLMAN CAR CO. LTD.*

•

INTEGRAL TUBULAR CONSTRUCTION
QUIET RIDING
METRO-SCHLIEREN BOGIES
SPECIAL GANGWAYS
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**METROPOLITAN-CAMMELL CARRIAGE & WAGON CO. LTD.**

HEAD OFFICE: SALTLEY, BIRMINGHAM 8 ✻ LONDON OFFICE: VICKERS HOUSE, BROADWAY, WESTMINSTER S.W.1.

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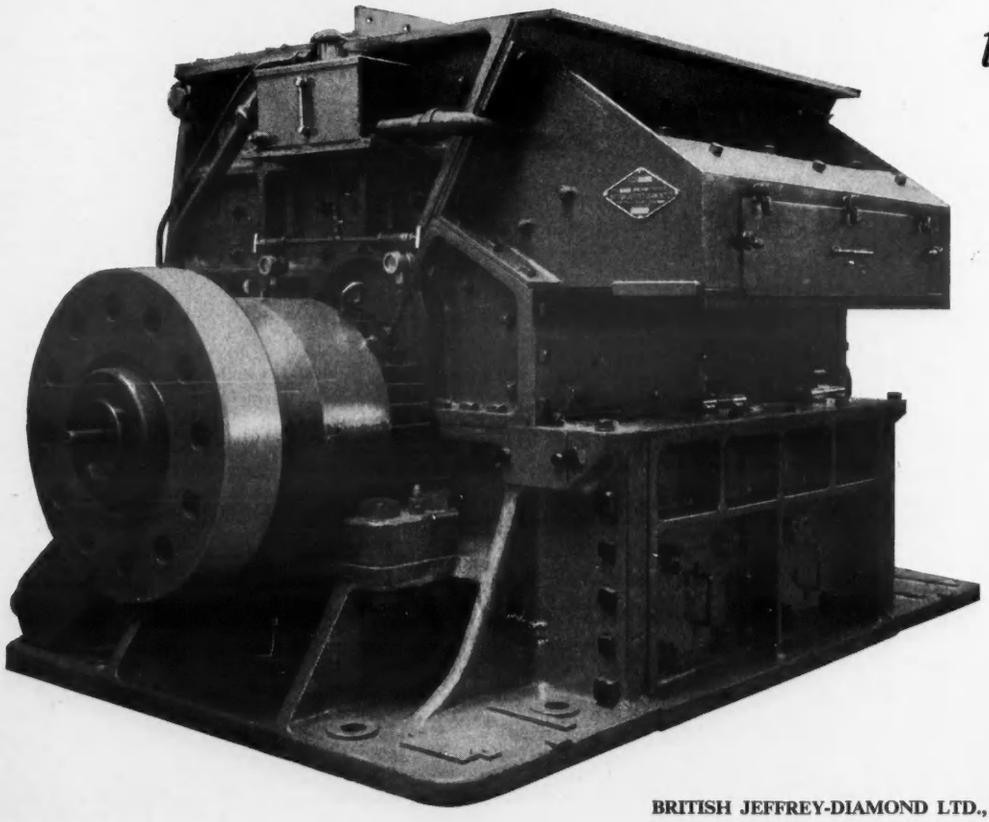
# Reducing industrial materials



## *to fine products..*

THE industrial materials reduced by the B.J-D Swing Hammer Pulveriser form an impressive list—from lime to plastics, and including many industrial chemicals. This machine, introduced many years ago and constantly developed to meet current applications, is distinguished by the high quality of its design and workmanship. The recently introduced Reversible Pulveriser enables both tips of the hammers to be used without losing time changing over.

BJD

**Pulverisers**

BRITISH JEFFREY-DIAMOND LTD., Crusher & Industrial Division, Thornes, Wakefield, Yorks.

WF 5168

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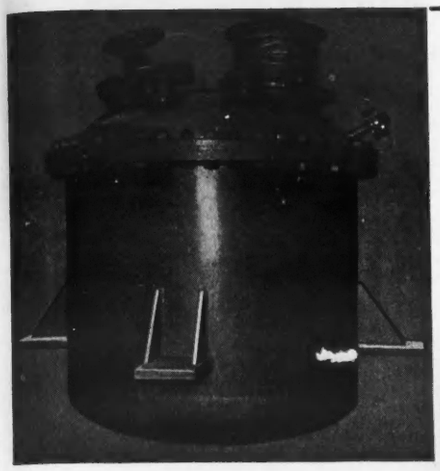

# CHEMICAL PLANT & EQUIPMENT

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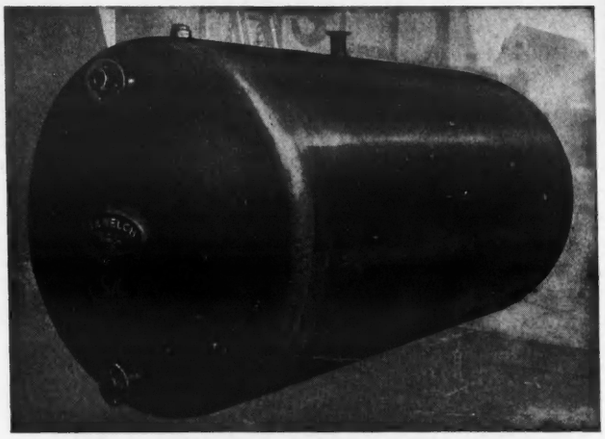
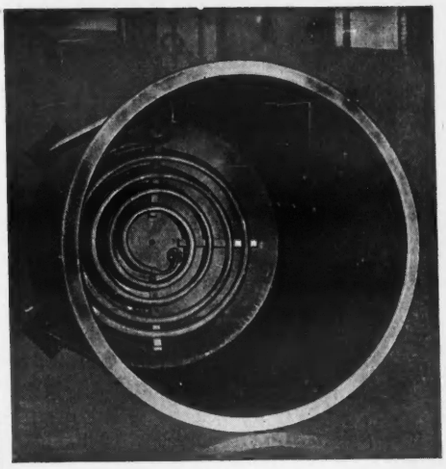
ALUMINIUM
STAINLESS STEEL
MILD STEEL





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CONDENSERS
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REACTORS Etc.

PRESSURE VESSELS
OF ALL KINDS

DELIVERIES PROMPT
PRICES COMPETITIVE

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ALL METALS

## J. A. WELCH (PLANT & VESSEL) LTD.

STALCO WORKS, LIVINGSTONE RD., LONDON, E.15
TELEPHONE: MARYLAND 5818 (3 lines).

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ROUNDS · HEXAGONS
SQUARES · FLATS & SECTIONS

## THE HALESOWEN STEEL Co, LTD

HALESOWEN
Nr BIRMINGHAM
HALESOWEN 1191

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BRIDGE STREET,
LONDON S.W.I. WHI 2015
8 CHATHAM ST
MANCHESTER, I. CEN 0413

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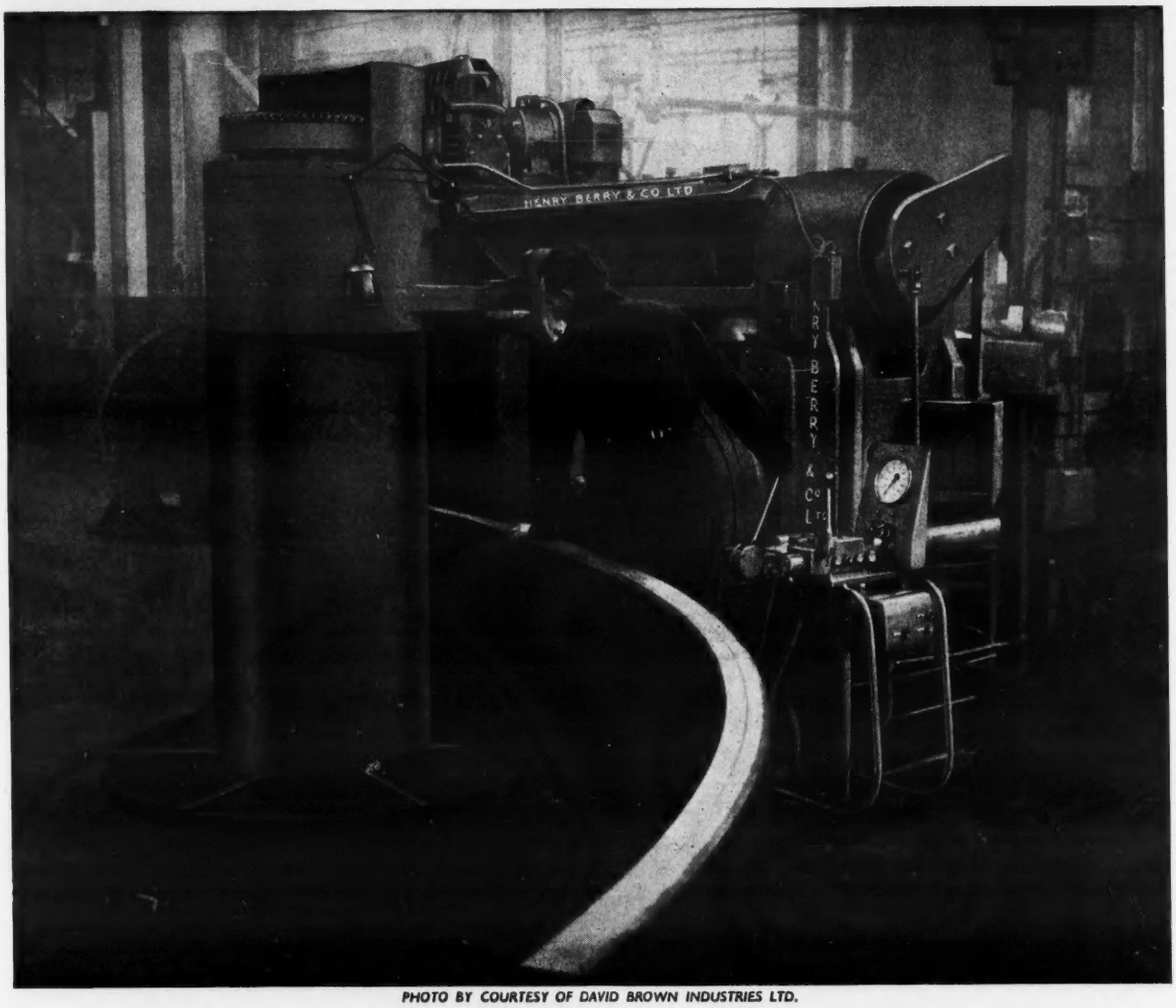
# Metal Forming MACHINES!




VERTICAL PLATE BENDING PRESS

PHOTO BY COURTESY OF DAVID BROWN INDUSTRIES LTD.

## ALMOST A CENTURY OF EXPERIENCE

**Vertical Plate Bending Press for bending thick plate. Special features are incorporated to facilitate manipulation of the sections. The photograph shows cold bending of a 30″ × 3½″ high tensile steel plate.**

*We also manufacture :*
**High Pressure Hydraulic Plant for Shipyards and Railway Workshops, Presses, Plate Bending Rolls, Punching and Shearing Machines, Continuous Finishing Presses for Silks and Rayons, Veneer and Plywood Presses, Cotton Baling Presses, Die Spotting Presses, Pumps, Accumulators, Valves and Intensifiers.**

# HENRY BERRY & CO., LTD.

**CROYDON WORKS, LEEDS, 10.**

*' Phone : LEEDS 75481-2*
*Grams : " RIVETTER, LEEDS 10 "*

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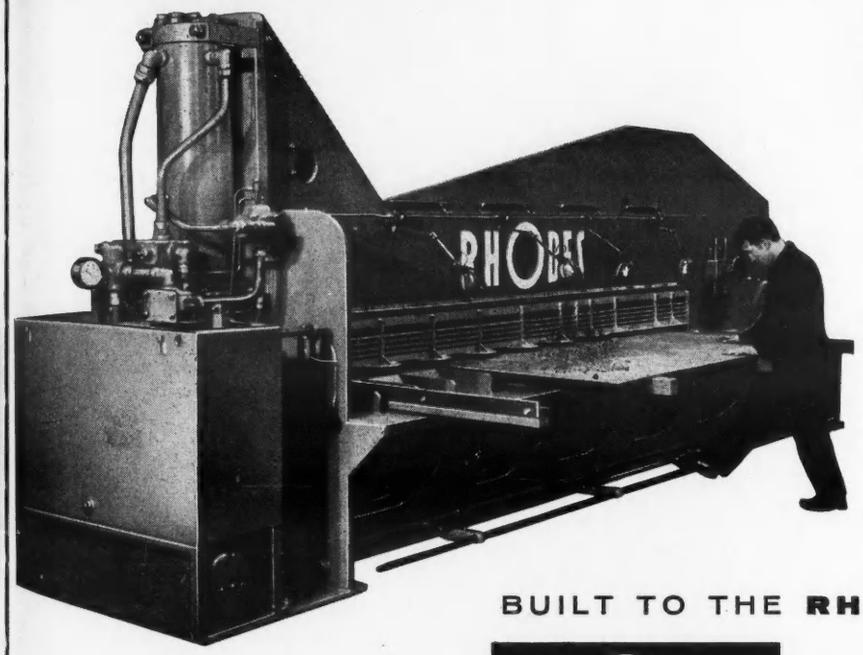
**RHODES**
*HYDRAVERSAL SHEARS...*

# this isn't a 'gimmick'
## *it's a Shear necessity*




It seems to have become a habit to describe any new machine as "Revolutionary" —the word has lost its meaning— and most of these so-called revolutionary machines are the same old designs with a gimmick tagged on to them. This puts us in a quandary. For how else should we describe the Hydraversal Shears? It does the work of 5 machines, costs less than one. You can get rid of your plate shears, cropping shears, trimming shears, billet shears, slab shears — the Hydraversal will do all their jobs better than they did it themselves. Trim a sheet or crop a billet—without adjustment. You can't break it. The secret is the patented "reverse-scissor" action. Revolutionary? Just a gimmick? Or, as we believe, a matter of intelligent simplification? Plus know-how—136 years of it.

BUILT TO THE **RHODES** STANDARD

*...Does work of 5 machines. Costs less than 1.*

**RHODES OF WAKEFIELD**

JOSEPH RHODES AND SONS LIMITED
BELLE VUE · WAKEFIELD · TELEPHONE 2756 (3 lines)

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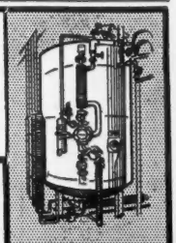
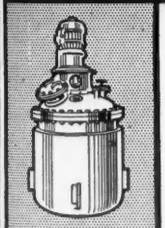
# Caston Barber

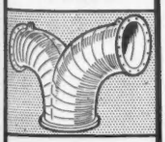
HEAVY DUCTING



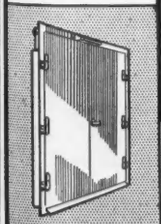
HIGH VACUUM VESSELS



MIXING VESSELS



FABRICATED PIPES AND DUCTS

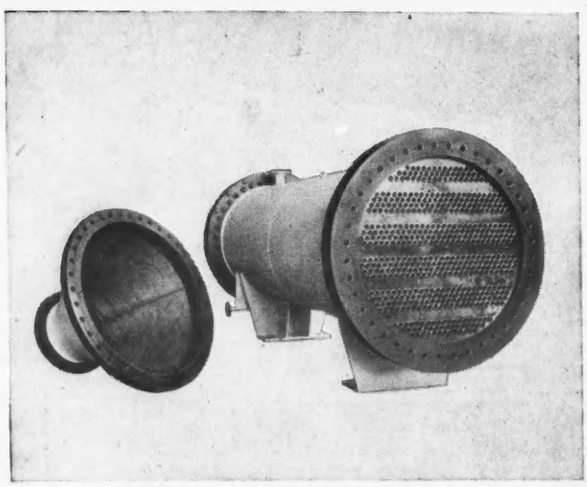


STEEL DOORS

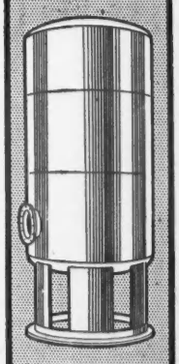
## for HEAT EXCHANGERS

DESUPERHEATERS, AUTOCLAVES.
HIGH VACUUM VESSELS,
WATER HEATERS, CONDENSERS,
STORAGE VESSELS,
PRESSURE VESSELS,
GENERAL FABRICATION
AND PIPEWORK

Rating of Heat Transfer Equipment, designs of Process Plant and fabriction to the various constructional codes.

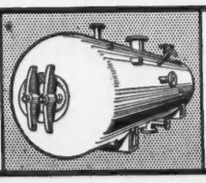


*One of a number of specially constructed Heat Exchangers*

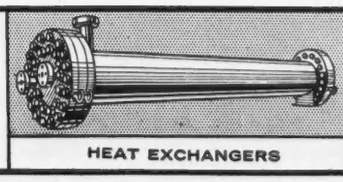


STORAGE TANKS

HYDRAULIC PRESSINGS

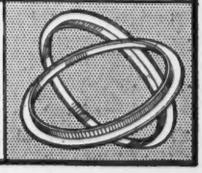


PRESSURE VESSELS



HEAT EXCHANGERS

ROLLED AND PROFILED FLANGE RINGS



*Write, call or telephone* CASTON BARBER LTD., 47 TABARD STREET, LONDON, S.E.1 TELEPHONE: HOP 1991/5

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INDUSTRIAL MAGNETS
for *INDUSTRY*

**Heavy Duty Lifting Magnet**

LIFTING MAGNETS FOR

SHIPYARDS AND STEELWORKS.
SUSPENSION MAGNETS AND
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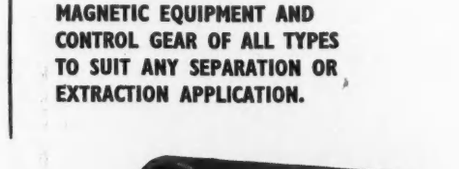
IN PROCESSING PLANTS.

MAGNETIC EQUIPMENT AND
CONTROL GEAR OF ALL TYPES
TO SUIT ANY SEPARATION OR
EXTRACTION APPLICATION.



**Electro and Permanent Magnetic Pulleys for the removal of Tramp Iron.**

INDUSTRIAL MAGNETS LTD

**INDUSTRIAL MAGNETS LTD.**

**28 Station Road, Acocks Green, Birmingham 27**

*Telephone: ACOCKS GREEN 0706*

★ ***Please write for Technical Brochure . . .***

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# STEEL TUBE

*made by*

## ARNOTT YOUNG

**is serving all branches of industry**

★ *Please send us your Enquiries :—*

**W. H. ARNOTT YOUNG & CO. LTD.**
Brookside Tube Works, Middleton St. George
Darlington. Telephone : Dinsdale 42

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# CLASSIFIED ADVERTISEMENTS

**PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS**

**Lineage Rate.** 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

**FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE**

**Lineage Rate.** 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 linch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

**Run-On and Semi-Displayed Styles.** Both these styles are available for single column width advertisements of any depth up to 12 inches.

**Displayed and Illustrated Styles.** The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

**Use of Box Number.** 2/- which includes forwarding of replies.

**Copy Dates.** Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

*Urgent advertisements may be telephoned to CENtral 6565.*

## PUBLIC APPOINTMENTS

### CITY OF SHEFFIELD EDUCATION COMMITTEE

#### COLLEGE OF TECHNOLOGY

#### DEPARTMENT OF ENGINEERING

Applicants for the following posts should hold graduate or equivalent qualifications and be adequately experienced in both industry and in teaching.

(a) SENIOR LECTURER IN PRODUCTION ENGINEERING (new appointment)

The person appointed will be expected to teach Machine Tool Theory, Metrology and other Production Engineering subjects of the new scheme of the Institution of Production Engineers to Higher National Certificate and Higher National Diploma students. He will be responsible for the new, very well-equipped Machine Tool and Metrology laboratories. He will be expected to assist in the promotion of research and laboratory work in production engineering subjects, in the development of the Higher National Diploma course and in organising special advanced courses in production subjects. An interest in the application of automatic control to manufacturing equipment will be welcomed.

The following vacancies arise from the appointment of the present holders to higher posts. Corporate membership of the Institution of Mechanical Engineers is essential for both posts.

(b) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Strength and Properties of Materials and Applied Mechanics A.1 and S.3 in Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Strength of Materials laboratory and will be expected to assist in the promotion of research, laboratory work and special advanced courses in relevant subjects. Interest in and knowledge of experimental work in the mechanical deformation of metals will be welcomed.

(c) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Theory of Machines and Applied Mechanics A.1 and S.3 in the Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Theory of Machines and Applied Mechanics laboratories and will be expected to assist in the promotion of research, laboratory project work and special advanced courses in relevant subjects. A knowledge of and interest in automatic control devices will be welcomed.

It is desirable that the successful candidates should take up duties on 1st September, 1960.

Salary : £1550 by £50 to £1750 per annum.

Application forms, obtainable from the undersigned (s.a.e.) at P.O. Box 67, Sheffield, 1, should be returned within 14 days of the appearance of this advertisement.

T. H. TUNN,
Director of Education.

E5191

### UNIVERSITY OF LIVERPOOL

#### DEPARTMENT OF MECHANICAL ENGINEERING

#### LECTURER

Applications are invited for the post of LECTURER in the Department of Mechanical Engineering. The initial salary will be within the range £1050 to £1350 per annum, according to age, qualifications and experience. Candidates should have a good Honours degree and experience in the general field of Applied Mechanics would be an advantage.

Applications, stating age, academic qualifications and experience, together with the names of three referees, and quoting reference No. CV/E should be received not later than 9 July, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E5137

### ROYAL NAVAL COLLEGE

#### GREENWICH

#### SENIOR LECTURER IN MATHEMATICS

Pensionable post for man at least 26 on 1st January, 1960 with 1st or 2nd class honours degree in Mathematics. Teaching experience in both pure and applied mathematics essential. Appointment in September, 1960, or soon as possible thereafter. Salary scale £1233 to £1460. Starting salary may be above minimum. Single accommodation available. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/5154/60. Closing date 21st July, 1960. E5196

## PUBLIC APPOINTMENTS

### NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1

#### APPOINTMENTS

Northampton College of Advanced Technology, St. John Street, London, E.C.1, requires :

(1) LECTURERS and SENIOR LECTURERS with honours degrees and industrial or research experience for the following subjects :

MECHANICS OF FLUIDS
MECHANICS OF MACHINES
APPLIED THERMODYNAMICS
STRENGTH OF MATERIALS

(2) ASSISTANT LECTURER in ENGINEERING DRAWING, preferably with degree or equivalent, and industrial experience.

These vacancies arise from the continued expansion of the College in Degree, Diploma in Technology, and post-graduate studies.

Salary scales : Senior Lecturer, £1588 rising to £1801. Lecturer, £1408 rising to £1601. Assistant Lecturer, initially in range £828 to £1263, rising to £1291 to £1396.

Particulars and forms of application are obtainable from the Secretary. E5143

### UNIVERSITY OF GLASGOW

#### DEPARTMENT OF MECHANICAL ENGINEERING

#### LECTURESHIPS IN MECHANICAL ENGINEERING

Applications are invited for LECTURESHIPS IN MECHANICAL ENGINEERING, tenable from 1st October, 1960, or such later date as may be agreed. Salary scale : £1050 to £1850 per annum. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applicants should be qualified in some branch of Applied Thermodynamics or Applied Mechanics (including Automatic Control) or Engineering Materials. New laboratories and equipment provide excellent scope for teaching and research.

Applications ( 3 copies) should be lodged, not later than 8th August, 1960, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

E5216

### WATFORD TECHNICAL COLLEGE

#### HEMPSTEAD ROAD, WATFORD, HERTFORDSHIRE

#### LECTURER IN MANAGEMENT SUBJECTS

Applications are invited for appointment from 1st September as LECTURER IN MANAGEMENT SUBJECTS.

Applicants should be fitted by qualifications and industrial experience to teach classes at B.I.M. Diploma Level and Industrial Administration post-H.N.C. Mechanical and Production Engineering students.

Salary on Burnham Scale for Further Education Establishments, viz : £1370 x £35 (and one of £40) to £1550 (men). Position on scale determined by previous experience.

Further particulars and application forms obtainable from the Registrar. Completed application to be returned to the Principal by 4th July, 1960. E5221

### NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1

#### GRADUATE RESEARCH ASSISTANTS

GRADUATE RESEARCH ASSISTANTS are required by Northampton College of Advanced Technology, St. John Street, London, E.C.1, for projects in Applied Photoelasticity, Fatigue of Metals and Impact Testing. Those appointed will be expected to work for a Higher Degree of London University. Salary about £500 p.a., including payment for some assistance in laboratory and tutorial classes. Candidates graduating this year will be considered.

Further particulars and application forms ar obtainable from the Secretary. E5144

## PUBLIC APPOINTMENTS

### ROYAL TECHNICAL COLLEGE OF EAST AFRICA AND PROPOSED UNIVERSITY IN NAIROBI

#### LECTURESHIPS

Applications are invited for LECTURESHIPS in :

(A) ELECTRICAL ENGINEERING ;
(B) MECHANICAL ENGINEERING (in one or more of the following subjects):
  (a) Strength of Materials
  (b) Fluid Mechanics
  (c) Theory of Machines
(C) LAND SURVEYING.

Salary scale : £1245 by £60 to £1,845 p.a., entry point according to qualifications and experience. Superannuation. Child allowance £50 p.a. per child (maximum £150 p.a.). Passage for appointee and family (up to 4 adult passages) on appointment, termination and leave (once every two years). Rent according to quarters provided £60 to £114 p.a. Detailed applications (6 copies) naming 3 referees by 20 August, 1960, to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E5226

### WARRINGTON TECHNICAL COLLEGE

#### TEACHER OF MACHINE SHOP ENGINEERING

TEACHER OF MACHINE SHOP ENGINEERING, Grade "A," is required to teach mainly in the City and Guilds courses, including block release courses, in Machine Shop Engineering. The salary is in accordance with the Burnham Technical Scale for Assistants, Grade "A": £520 by £27 10s. to £1000 with additions for qualifications and training. Approved experience in industry qualifies for increments on the scale.

Application forms and further particulars may be obtained, on receipt of a stamped, addressed foolscap envelope, from the Chief Education Officer, Education Office, Sankey Street, Warrington. E5224

### BOROUGH OF SHREWSBURY

#### WATER DEPARTMENT

#### APPOINTMENT OF AN ASSISTANT ENGINEER

Applications are invited for the above established appointment within salary A.P.T. Grade II (£765 to £880) according to qualifications and experience.

HOUSING ACCOMMODATION WILL BE PROVIDED IF REQUIRED AND REMOVAL EXPENSES PAID.

The appointment is subject to the N.J.C. Conditions of Service, the Local Government Superannuation Acts, a satisfactory medical examination, and termination by one month's notice on either side.

Applications, stating age, qualifications and details of experience, together with the names of three persons to whom reference may be made, should be submitted to the Water Engineer and Manager, Water Department, Shelton, Shrewsbury, so as to be received not later than the 6th July, 1960.

S. R. H. LOXTON,
Town Clerk.

Guildhall,
Shrewsbury. E5208

### GOVERNMENT OF HONG KONG

#### PUBLIC WORKS DEPARTMENT

#### ELECTRICAL/MECHANICAL ENGINEER

Duties comprise the design, estimation, installation, operation and maintenance of air conditioning installations in large buildings including refrigeration plant.

Permanent and pensionable appointment. Salary according to experience within the range £1650 to £2865. Quarters at low rent. Free passages. Generous leave.

Candidates must be under 35 years and A.M.I.E.E. or A.M.I.Mech.E. with at least 3 years' post qualification experience in the refrigeration industry.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/51/033/D4. E5210

## PUBLIC APPOINTMENTS

### SCIENTIFIC CIVIL SERVICE

#### (A) SENIOR SCIENTIFIC OFFICERS (B) SCIENTIFIC OFFICERS

The Scientific Civil Service needs men and women for pensionable posts as (a) SENIOR SCIENTIFIC OFFICERS and (b) SCIENTIFIC OFFICERS in all major scientific fields, including

PHYSICS
ENGINEERING
CHEMISTRY
METEOROLOGY
MATHEMATICS and
BIOLOGY.

Age limits : (a) at least 26 and under 32 ; (b) at least 21 and under 29. Extension for regular Forces service and Overseas Civil Service. Qualifications : normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment ; additionally for (a) at least 3 years' relevant (e.g. post-graduate) experience. Selection by interview. London salaries (men) : (a) £1233 to £1460 ; (b) £655 to £1150 ; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting (a) S/53/60 ; (b) S/52/60. E5198

### NORTH THAMES GAS BOARD

#### TAR AND AMMONIA PRODUCTS WORKS, BECKTON, EAST HAM, E.6

#### DRAUGHTSMAN

DRAUGHTSMAN, aged 21 or over with O.N.C. required by North Thames Gas Board at the Tar and Ammonia Products Works, Beckton, East Ham, E.6.

The post offers the possibility of obtaining experience in the expanding field of chemical engineering for an applicant who has had a sound mechanical training.

Starting salary will be according to qualifications and experience and the successful candidate will be required to join a contributory Staff Pension Scheme. Five-day week.

Applications, giving age and full particulars, should be sent to the Staff Controller, North Thames Gas Board, 30 Kensington Church Street, W.8, quoting reference TE/839. E5222

### MINISTRY OF AVIATION

#### BRISTOL DISTRICT

#### TECHNICIAN

Ministry of Aviation requires a TECHNICIAN for supervision of inspection at approved and unapproved firms and control of skilled and semi-skilled staff engaged in direct inspection of armament stores in Bristol District.

Qualifications : Recognised engineering apprenticeship. O.N.C., appropriate C. & G. Final Certificate, or equivalent qualification. Experience in the physical inspection of instruments, empty armament components, materials and stores is essential. A knowledge of modern inspection techniques and an appreciation of fine measurement desirable. Salary : £700 (age 26) to £875 p.a. Application forms from Manager (P.E.1943), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E5225

### WAR OFFICE

#### LONDON

#### TECHNICIAN

War Office requires TECHNICIAN in London to investigate technical problems in production of armoured fighting vehicles ; cost estimating, preparation of instructions, schedules and requests for contracts ; progress at contractors' works. Qualifications : Recognised engineering apprenticeship ; sound practical workshop experience in machining and fitting operations on armoured fighting vehicles essential ; O.N.C., City and Guild Finals or equivalent. Salary : £900 (age 30) to £1065 p.a. Application forms from Manager (P.E.1908), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E5166

**Classified Advts. continued on page 136**

## PUBLIC APPOINTMENTS

### SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

#### REGIONAL ENGINEER'S DEPARTMENT

#### APPOINTMENTS

Applications are invited for appointments on the permanent staff of the Board generally in accordance with the Whitley Council conditions of service.

The Board is undertaking a considerable programme of hospital development and the persons appointed will be engaged on varied and interesting work.

ENGINEERING GENERAL GRADE

Applicants should be (i) Corporate Members of the Institution of Mechanical Engineers and experienced in the preparation of specifications, drawings and estimates for large engineering installations in hospitals and large public buildings, or (ii) Corporate Members of the Institution of Heating and Ventilating, or (iii) have served a recognised engineering apprenticeship and be Graduate Members of the Institution of Mechanical Engineers, having passed A and B of the Associate Membership examination, or hold exempting qualifications. Sound experience of design of mechanical services of large buildings required. Drawing Office and Estimating experience an advantage.

Salary scale (on or after 1st July, 1960) : £910 by £35 (1) by £40 (2) by £45 (5) by £50 (7) to £1600 p.a. Bar at £1205 for graduate members and at £1400 for Corporate members of the Institution of Heating and Ventilating. Corporate Members of the Institution of Mechanical Engineers commence at £1160 p.a. London Weighting allowance of £40 to £50 p.a. payable in addition.

Applications, stating age, qualifications, experience, present appointment and salary, together with the names and addresses of three referees, should be sent to the undersigned at 40, Eastbourne Terrace, London, W.2, by not later than 9 July.

E. G. BRAITHWAITE,
Secretary.
E5209

### MINISTRY OF AVIATION

#### GLASCOED, USK, MON.

#### TECHNICIAN

Ministry of Aviation requires a TECHNICIAN at Glascoed, Usk, Mon., to take charge of a section engaged on the inspection of incoming empty components for ammuntion stores. Work calls for supervision of skilled staff carrying out inspection by direct measurement and assessment of finishes, etc., and the preparation of appropriate instructions. Qualifications : Recognised engineering apprenticeship. O.N.C., appropriate City and Guilds Final Certificate, or equivalent qualification. Considerable experience in the inspection of a wide variety of empty ammunition stores. Knowledge of the filling of ammunition and the safety regulations concerned an advantage. Housing may be available. Salary. £850 (age 30) to £1005 p.a. Application forms from Manager (P.E. 1895), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.
E5197

### MANCHESTER CORPORATION WATERWORKS

#### ASSISTANT ENGINEERS

Applications are invited for the undermentioned appointments in connection with the design and construction of treatment and filtration plant, and large service reservoirs, the reconstruction of existing reservoirs, and the reconditioning of main aqueduct :

Assistant Engineers (Class II) : £785 to £1070.
Assistant Engineers (Class III) : £610 to £880.

Applications, stating (1) age ; (2) education and training ; (3) professional qualifications ; (4) experience in the preparation of plans and construction of waterworks and other civil engineering works, together with the names of two referees, should be addressed to the Engineer and Manager, Waterworks Offices, Town Hall, Manchester, 2, not later than 12th July, 1960.
E5219

### MINISTRY OF AVIATION

#### LONDON

#### TECHNICIAN

Ministry of Aviation requires a TECHNICIAN in London to carry out detail work in connection with programming of weapon components, test gear and ground handling equipment.

Qualifications : Recognised engineering apprenticeship. O.N.C., appropriate C. & G. Final Certificate, or equivalent qualification. Some experience of drawing office work and the production of light engineering components. Salary : £900 (age 30) to £1065 p.a. Application forms from Manager (P.E.1942), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.
E5228

### CIVIL SERVICE COMMISSION

#### CIVIL, STRUCTURAL, AND PUBLIC HEALTH ENGINEERS

Pensionable posts for men and women at least 25 and and under 35 at 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects. Salary (men, London) £830 to £1125 according to age, rising to £1300. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/64-66.
E5195

## PUBLIC APPOINTMENTS

### MINISTRY OF AVIATION

#### FARNBOROUGH, HANTS

#### TECHNICIAN

Ministry of Aviation requires a TECHNICIAN at Farnborough, Hants, for mechanical testing and metallographic examination of routine test pieces and of Service defects and failures.

Qualifications : Recognised engineering apprenticeship or equivalent training in an appropriate trade. O.N.C., appropriate C. & G. Final Certificate or equivalent. Some knowledge of material testing essential. Salary : £680 (age 26) to £850 p.a. Application forms from Manager (P.E.1941), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.
E5227

## TENDERS

### BRAINTREE & BOCKING U.D.C.

#### CODHAM MILL WATER SCHEME

#### CONTRACT NO. 8—PIPELAYING

The Council invite TENDERS from experienced Public Works Contractors, who specialise in PIPELAYING, for the laying of approximately 5½ miles of 9in., 10in., 15in. and 21in. spun iron pipes with flexible joints and the construction of ancillary works.

The General Conditions of Contract, Specification, Bill of Quantities, Form of Tender and Drawings, prepared by the Consulting Engineers, Messrs. Herbert Lapworth, Partners, 25, Victoria Street, Westminster, S.W.1., may be obtained from the Undersigned on or after Monday, 27th June, 1960, on payment of a cheque for £10 made out in favour of the Council, which amount will be refunded on receipt of a bona-fide Tender not subsequently withdrawn.

The Tender is to be returned addressed to the Undersigned in a sealed envelope endorsed " Tender for Codham Mill Water Scheme, Contract No. 8," and to reach the Town Hall on or before noon on Monday, 25th July, 1960.

The Council does not bind itself to accept the lowest or any Tender.

W. BALSON,
Clerk of the Council.
Town Hall,
Braintree, Essex.
E5154

### METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

#### NEW SOUTH WALES

#### WATER SUPPLY

#### CONTRACT NO. 3416-W-

TENDERS are invited for the DESIGN, MANUFACTURE, SUPPLY, DELIVERY and INITIAL MAINTENANCE of FIVE (5) AUTOMATIC STOP VALVES of 15in. nominal bore or nearest standard size.

Remote controlled operation of Four (4) of these valves is required and the associated electrical equipment is to be included in the contract.

Tender documents including the specification and schedules can be obtained on application to the Agent-General for New South Wales, 56-57, Strand, London, W.C.2.

Tenders must be delivered to the Metropolitan Water Sewerage and Drainage Board, 341, Pitt Street, Sydney, New South Wales, Australia, by 2.0 p.m. on Tuesday, 23rd August, 1960. E5181 T

### HEAVY ELECTRICALS LIMITED

#### BHOPAL, INDIA

Invite the following TENDERS :

(a) TENDER No. PP/F/MT/60/6 for the SUPPLY of Shaft Press Drilling Machine, Bending Lathe, Shearing Machine, Grinding Machine, Punching Machine, Column type Drill, Band Sawing Machine, etc. Opening date 9th September, 1960.

(b) TENDER No. PP/FIT-9 for the SUPPLY of Diesel Shunting Locomotive. Opening date 6th September, 1960.

Tender forms and specifications can be obtained from Heavy Electricals Limited, Crown House, Aldwych, London, W.C.2, on payment of £1 10s. 0d. per set (a) above, and £2 12s. 6d. per set for (b) above.

The Tenders must reach Heavy Electricals Limited, Post Box No. 46, Bhopal, India, before the opening dates specified.
E5212

### INDIA STORE DEPARTMENT

#### TENDER REF. NO. 16042/60/BMB/HAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

JIG BORING AND MILLING M/C—Table Travel 55in. Boring capacity 10in., table 62in. by 41in., with Optical Micro Setting device.

The Tender forms with Schedule and Specifications which are returnable on 14th July, 1960 may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Please quote the above reference number. E5211

## EDUCATIONAL

### UNIVERSITY OF LONDON KING'S COLLEGE

#### SHELL STUDENTSHIPS IN CHEMICAL ENGINEERING

Value £375 each, plus tuition fees. May be held for the one-year post-graduate course for the College Diploma in Chemical Engineering, or for the first year (with possible renewal) of higher degree work.

Applications are invited from graduates in Chemistry or Engineering. Forms must be obtained from the Registrar, King's College, Strand, London, W.C.2, and must reach him completed by July 4th, 1960.
E5173 E

### UNIVERSITY OF LONDON KING'S COLLEGE

#### TUTORIAL STUDENTSHIPS

are offered in the Departments of Civil Engineering, Electrical Engineering and Mechanical Engineering. The value is £425 a year, with free tuition, from 1st October, 1960. Applicants must be graduates or about to graduate, and will be required to read for a higher degree and to give a limited amount of assistance by demonstrating.

Particulars and forms from the Registrar, King's College, Strand, W.C.2, to whom completed applications should reach not later than July 4th. E5164 E

**A.M.I.MECH.E., B.SC.**, City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8.
E114 E

## SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

#### A QUALIFIED ENGINEER

is required by a leading paper converting Company for development work. Applicants should have wide experience in the manufacture of folding boxes. Knowledge of printing techniques is also required.

This is an interesting appointment in an organisation with a planned expansion programme.

Replies, which will be treated in strict confidence, should contain full details of career to date and should be addressed to BOX No. E5206, " The Engineer."
A

**A YOUNG ASSISTANT** required for Plant and Machinery Valuers. Well known London firm. Some knowledge of engineering an advantage.—Apply, stating experience, age and salary required to BOX No. E2890, " The Engineer." A

**AN ASSISTANT SALES ENGINEER** is required by Dresser (Great Britain) Ltd., Clark Bros. Co. Division. This Division is responsible to the United States Parent Company for the marketing of gas engines, motor driven reciprocating compressors, centrifugal compressors and gas turbines, manufactured under license in the United Kingdom and on the Continent. Candidates should be well qualified graduate mechanical engineers aged 28-35. The Company is a well-established European organisation and offers good pay and conditions, with a pension scheme. There are excellent prospects for early advancement to full sales engineering responsibilities.—Apply with full personal particulars and details of experience and previous appointments to Dresser (Great Britain) Ltd., Clark Bros. Co. Division, 197, Knightsbridge, London, S.W.7. E2904 A

**AN ENGINEER** is required to lead research into machinery and equipment used in the manufacture of brushes and to design apparatus for testing brushes. A graduate, or equivalent, able to work on his own will be adequately rewarded.—Write : F. Kidd, c/o Textile Department, University, Leeds, 2. E2908 A

**AIR CONDITIONING AND REFRIGERATION APPLICATIONS ENGINEER** required for work in Tropical West Africa by a leading British concern. Successful applicant will have wide scope for designing and selling complete installations in an expanding market using both British and American equipment. Good experience in this field is essential. A starting salary from £1500 per annum according to qualifications and experience is offered with free accommodation, generous conditions of service and regular home leave.—Apply with full particulars to BOX No. E5200, " The Engineer." A

#### CENTRAL ELECTRICITY GENERATING BOARD

EASTERN DIVISION

Applications are invited for the following appointment at Divisional Headquarters (Cockfosters in North London).

DRAUGHTSMAN

Salary N.J.B., Schedule D, Grade 5, £830 by £20 to £940 per annum, or Grade 6, £660 by £20 to £780 per annum.

The grade and commencing salary will be within the above ranges at a point commensurate with qualifications and experience.

The duties of the applicant appointed will include work on the layouts for high voltage transmission lines, substations and electrical diagrams.

Applicants should have technical qualifications to the standard of Ordinary National Certificate and should have had experience of this type of work.

Applications, quoting S.V. No. 1287, stating age, qualifications, experience and present position should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts, to arrive not later than 9th July, 1960. E5192 A

## SITUATIONS VACANT

**AREA MANAGER** required by Structural Engineering Firm for existing North East Coast office. Engineering background essential, applicants with North East connections preferred. Excellent terms of employment including pension scheme. Communicate in strict confidence, stating age, qualifications, past experience and salary required to BOX No. E5182, " The Engineer." A

**ASSISTANT PUMP ENGINEER** required. Duties include application, sales and contract correspondence, cost estimating, design development. Excellent opportunity. Age 22-26. H.N.C. Previous apprenticeship and experience with centrifugal pumps desirable.—Write or phone for application form to Allis-Chalmers Great Britain Limited, 728, Salisbury House, London Wall, London, E.C.2 NATional 0821. E2889 A

#### BRITISH HYDROCARBON CHEMICALS LIMITED

have vacancies for

#### MECHANICAL ENGINEERS

at their rapidly expanding Grangemouth Works preferred ages 22-28, but older fully qualified Mechanical Engineers can also be considered. Applicants must have a degree in engineering or have been accepted as graduate members of the Inst. Mechanical Engineers. Practical training can be provided where necessary towards qualifying as A.M.I.Mech.E. Salaries will be in accordance with qualifications and experience, and a non-contributory pension scheme is in operation.—Replies should be addressed to the Administrative Officer, British Hydrocarbon Chemicals Limited, Bo'ness Road, Grangemouth, Stirlingshire.

E5177 A

**CLERK OF WORKS** (temporary) required for supervision of contracts for the construction of new locks and other works on the River Lee Navigation and at Regents Canal Dock, Stepney. Must have experience in supervising large civil engineering contracts ; experience in mass concrete and steel sheet piling desirable. Salary £900 to £1000. Certain railway privilege travel facilities.—Apply, in writing, giving full particulars to : Divisional Staff Assistant, British Waterways, " Willow Grange," Church Road, Watford, Herts, not later than 11th July, 1960. E5189 A

**CONSTRUCTION.** Qualified Engineers with considerable experience pipeline, pumping station and tank farm construction required by leading international firm for Middle East.—Write Box No. 3478, c/o Charles Barker and Sons Limited, Gateway House, London, E.C.4. E5162 A

**DESIGN / DRAUGHTSMEN** — Piping Layout, Piping Checkers, Piping Arrangements and Civil with specialised knowledge of Oil Refinery and Chemical plants for progressive positions in London Office of an expanding Anglo-American Company. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Limited, 16-26, Baltic Street, E.C.1 (Phone CLE 4388). E5059 A

**DETAILER AND DESIGNER** required by expanding firm making up-to-date mechanical aids for the Building Industry. Holiday arrangements honoured. —Write, giving full details of experience and qualifications to BOX No. E2903, " The Engineer." A

**ENGINEER** with O.N.C. or equivalent and aged around 27 is required for Works in Chester to assist in the supervision of installation and maintenance of metallurgical plant and factory services. The plant includes hydraulic presses, compressors, rolling mills, smelting furnaces and various types of conveying and elevating equipment. The position would suit a man who has confidence in his ability to lead small teams of first class practical men on all manner of jobs. The post is a staff one and there is a pension scheme. Salary in the region of £750 to £850.—BOX No. E5184, " The Engineer." A

**ENGINEER** required for examination and reporting on chains, ropes and lifting tackle. Should have experience in the making of such plant. Essex area. Starting salary £800 per annum.—Write Box E586, LPE, Romano House, 399-401, Strand, London, W.C.2. E5232 A

**ENGINEERING DESIGN.** TECHNICIAN for work on engineering design and vibration/shock calculations required by expanding concern in East Midlands. Graduates who are interested in the scientific approach to engineering should give details of education, previous experience and present position.—BOX No. E5187, " The Engineer." A

#### ENGINEERING DRAUGHTSMAN

Two vacancies have occurred at Etruria Gas Works, Stoke-on-Trent.

The duties involve assisting in the design and layout of Structural and Mechanical plant and pipework.

Candidates should possess at least an appropriate Ordinary National Certificate and have had experience in an engineering drawing office.

The salaries for the appointments, which are pensionable, will be within the range of £629 to £813 per annum, according to qualifications and experience.

Applications, stating age, qualifications, and experience, should be addressed to Mr. L. W. Johnson, Divisional General Manager, West Midlands Gas Board, Etruria Gas Works, Stoke-on-Trent, Staffs. E5220 A

**ENGINEERS** for inspection of cranes and lifting plant. Must have drawing office experience of design of cranes, also National Certificate in Mechanical Engineering. Essex, Warwickshire and Liverpool areas. Starting salary £800 per annum. Non-contributory pension—permanent.—Apply : Engineering Dept., GENERAL ASSURANCE CORP. LTD., Aldwych, London, W.C.2. E5231 A

**ESTIMATING DESIGNER/DRAUGHTSMAN** required by a small but rapidly expanding Engineering Company. The work is of a varied and interesting nature, including light and heavy fabrications, general machining machinery design and lay-out, etc. Applicants should be able to discuss technical problems with customers and have proven ability for original design. Knowledge of hydraulics and/or pneumatics would be an advantage. Candidates, who should have workshop experience, age 25-35 possessing O.N.C. (Mech.) preferred, but older men would be considered, should write in the first instance giving age, experience and salary required to : Managing Director, Mepel Co., Ltd., 105 Fairfield Road, Bow, London, E.3. E2899 A

## SITUATIONS VACANT

**ESTIMATING ENGINEER** for progressive position with prominent London firm of Land and Marine boiler engineers. Drawing office experience essential; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., to BOX No. E5138, "The Engineer." A

**GEAR DESIGN ENGINEER** required with experience marine gearboxes or V.P. propellers. Vacancy is in busy and expanding Technical Dept. where good salary will be paid for the right man, having H.N.C. or equivalent. Existing holiday arrangements respected. Superannuation scheme. Free life insurance.—Apply: Technical Manager, MODERN WHEEL DRIVE LTD., Lindo Lodge, Stanley Avenue, Chesham, Bucks. E5179 A

**HYDRAULIC PRESS MANUFACTURER** requires SENIOR DESIGN ENGINEER to take charge of small expanding design office. Preferment given to man with broad experience in Press design, coupled with initiative and originality.—Write, giving details of age, experience and salary required to BOX No. E5180, "The Engineer." A

**IMPORTERS REQUIRE REPRESENTATIVES** already calling on Engineering Concerns to carry Welding Cutting Equipment and Machine Tools.—BOX No. E191, "The Engineer." A

**INSTRUMENT ENGINEERS.** This expanding Anglo-American Company offers progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical plants. They are required for work on preparation of specification for equipment associated with process control systems. Minimum qualifications: engineering degree or equivalent and 2 years or more experience in similar work. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Ltd., 16-26, Baltic Street, E.C.1. (Phone CLE 4388). E5057 A

**J. SAINSBURY LTD.,** Food Manufacturers and Distributors require a JUNIOR SHOP FITTING DRAUGHTSMAN, aged 19-20, for their Shop Planning Department at Blackfriars. Commencing salary will depend on qualifications and experience, but will be in the region of £500 per annum. Permanent progressive and pensionable position.—Write, giving full details of education and experience to: Personnel Department, J. Sainsbury Ltd., Stamford House, Stamford Street, London, S.E.1. E5229 A

**KENWOOD MANUFACTURING (WOKING) LTD.**

A CHIEF ENGINEER is required to take charge of Research, Design and Development for domestic appliances.

The appointment represents a fine opening for an experienced and capable Engineer who has a proven record in domestic appliance design.

Mechanical and Electrical qualifications essential, coupled with drive, initiative and the ability to organise a team of specialists.

An excellent salary will be paid to the selected applicant and the position is superannuated.

Applications, which will be treated in the strictest confidence, should be in writing, setting out full particulars of previous experience, age, and present salary. They should be marked "Strictly Confidential," and addressed to the Works Director, Kenwood Works, Hipley Street, Woking, Surrey. E2909 A

**LARGE MIDLANDS STEEL WORKS,** Birmingham Area, requires MECHANICAL DRAUGHTSMAN for layout and detail work in connection with development and maintenance. Applicants should have a good knowledge of Heavy Engineering. Steelworks experience an advantage but not essential. Excellent prospects to suitable applicant. 38-hour week. Alternate free Saturday. Social recreation and canteen facilities. Pension scheme.—Apply, stating age and experience to BOX No. E5217, "The Engineer." A

**LARGE MIDLANDS STEEL WORKS,** Birmingham Area, requires a SENIOR DESIGN SECTION LEADER DRAUGHTSMAN. Applicants should have had experience of Steel Works or Heavy Engineering, including foundation and layout work. Alternate free Saturday, Social, Recreation and Canteen facilities. Pension and free insurance scheme in operation.—Apply, stating age, qualifications, details of experience and salary level expected to BOX No. E5218, "The Engineer." A

**MACHINERY INSTALLATION DRAUGHTSMAN** required, with good experience on vessels up to 250 feet. A knowledge of estimating and electrical installation work an advantage.—State age, full particulars of experience and salary required to Philip & Son, Limited, Shipbuilders, Dartmouth, Devon. E2901 A

**PILKINGTON BROTHERS LIMITED,** St. Helens, have a vacancy in their Technical Development Section at City Road Works for a DRAUGHTSMAN. The work would be concerned with the design and development of glass working machinery and associated plant; he would also be responsible for producing designs based on experiments carried out in the Department, and should be capable of carrying the job through from drawing-board to plant.

Age rate: 25 to 30.

Minimum qualifications O.N.C. (Mechanical Engineering).

Some practical experience is required.

Applications should be addressed to Group Staff Department, Pilkington Brothers Limited, Grove Street, St. Helens, Lancashire. E5193 A

**MECHANICAL ENGINEERS** are required by an expanding Anglo-American Company, offering progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical Plants. These positions call for specialised work in design of Petroleum and Chemical plants and equipment. Minimum qualifications B.Sc. and 2 years or more experience in this field. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Limited, 16-26, Baltic Street, E.C.1. (Phone CLE 4388). E5058 A

**PROCESS ENGINEERS** are required by an expanding Anglo-American Company offering progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical Plants. These senior positions call for full responsibilities for Chemical Engineering design of large process units. Minimum qualifications: Honours degree Chemical Engineering and 5 years or more experience in this field. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Ltd., 16-26, Baltic Street, E.C.1 (Phone CLE 4388). E5056 A

**SALES ENGINEER,** required to promote the sales of a new product which facilitates the erection of steel structures. Experience in the design and erection of structural steelwork and a good knowledge of welding are necessary.—Details of experience and salary required to BOX No. E2891, "The Engineer." A

**SÃO PAULO LIGHT S.A.-SERVIÇOS DE ELETRICIDADE,** a Company in Brazil and a subsidiary of the Canadian corporation, Brazilian Traction, Light and Power Company Limited, invite applications from suitably qualified men for the position of DEPUTY CHIEF of its PIRATININGA POWER STATION. The power station was completed about five years ago and is situated near São Paulo (population over 3 millions; temperate climate, 2200 ft. above sea level). The plant comprised initially 2 by 100 MW, 1800 r.p.m. steam turbo-generator units each supplied at 850 p.s.i., 900° C. by one 850,000 lbs/hr. oil-fired boiler and has been recently expanded by the addition of two 125 MW. reheat units, 1800 p.s.i., 1000° F. Applicants should have sound technical knowledge and good practical experience in the administration, operation and maintenance of steam-electric power stations; should also be of strong character with an aptitude for supervision and the maintenance of harmonious labour relations. Good salary, three years agreement with first class passage both ways; four months paid leave after three years service. —Written application in the first instance should be made to Mr. Osborne Mitchell, General Manager, Canadian-Brazilian Services Limited, 9-12 Cheapside, London, E.C.2. E5127 A

**SENIOR DRAUGHTSMAN,** O.N.C. (min.) required. Experience in one or more of the following essential; Cranes, Excavators, truck-mounted Mobile Cranes and Contractors Plant. Good staff conditions. Pension scheme.—Applications in writing, all relevant particulars and approximate salary required to: Personnel Manager, Ruston-Bucyrus Ltd., Excavator Works, Lincoln. E5215 A

**SENIOR REFRIGERATION ENGINEER** required by South London Company specialising in installation of equipment up to 20 h.p. and manufacture of own Displays, Cabinets, &c. Must be able to manage our own Field Engineers, plan installations and offer technical advice to customers. This is an important position with a progressive company. Only fully skilled men with first-class references need apply.—Write full particulars to BOX No. E2912, "The Engineer." A

**SIR WILLIAM HALCROW AND PARTNERS,** Alliance House, Caxton Street, London, S.W.1, have vacancies for a RESIDENT ENGINEER and several Assistant Engineers for a harbour project in North Africa, for a CHIEF ASSISTANT and an Assistant Engineer on a harbour project in the Persian Gulf, and for DESIGN ENGINEERS in their London Offices.—Apply in writing with full details, qualifications and experience. E5176 A

**STAFF VACANCIES** due to extensive modernisation programme, plant and buildings.

ENGINEERING AND BUILDING DEPARTMENT

1. ENGINEERING DRAUGHTSMAN. Experience must include general plant layout with some design experience. Some workshop training an asset.
2. ARCHITECTURAL DRAUGHTSMAN. Experience must cover industrial type buildings generally. Work involves site supervision and liaison with Architects and Contractors.
3. SHIFT ENGINEERS (MECHANICAL). Some experience in a supervisory capacity relative to plant maintenance essential. Emphasis on first class practical training, including hydraulic and pneumatic plant and services.

In all cases a broad general, rather than specialised knowledge is essential. For (1) and (3) Iron and Steel foundry experience would be useful.

Vacancies are in the Derby area. First class working conditions and amenities. Profit sharing and pension schemes. Housing assistance would be considered where applicable.

Applications in writing, marking envelope "Works Engineer," giving full information relative to experience, technical training and salary required. — BOX No. E5157, "The Engineer." A

**TECHNICAL ADVISER** required for Thermalite Ytong Limited, at their headquarters at Hams Hall, Warwickshire. The appointment will be as Deputy to the Chief Technical Officer, and duties will include giving technical advice to ARCHITECTS and CONTRACTORS on the use of the Company's material. A knowledge of Codes of Practice, British Standards, Bye Laws, etc., necessary, and applicants should hold A.M.I.Struct. E. qualifications or similar. Age 25-30 years.

The post, which is in a rapidly expanding Company, offers interesting work, and the appointment is progressive and pensionable.—Apply in the first instance to Personnel Manager (T.S.A.22), John Laing and Son (Holdings) Limited, Page Street, N.W.7. E5134 A

**THE HARLAND ENGINEERING CO. LTD.,** Alloa, invite applications for a SENIOR CONTRACTS ENGINEER with engineering and commercial experience in hydraulic and/or electrical engineering. Experience in power station work an advantage. Higher National Certificate in engineering or equivalent.—Full details of experience and salary required to Contracts Director. E5190 A

## CRANE DRAUGHTSMAN AND DESIGNERS

required with mechanical or structural experience for design of all types of Overhead Electric Cranes. Permanent position with very good prospects, Pension Scheme and assistance with housing if necessary. Applications which will be treated in strict confidence to:

**JOHN SMITH (KLY) LTD.,**
CRANE WORKS, KEIGHLEY, YORKS.

E5047 A

## AN ARCHITECTURAL or BUILDING DRAUGHTSMAN

is required by

**W. H. ALLEN SONS & COMPANY LTD.**

for their

**WORKS ENGINEERS DEPARTMENT**

Experience of architectural and civil engineering design is necessary and it is desirable that applicants should have had some basic technical training.

The Company offers excellent conditions of service, a contributory Pension and Life Assurance Scheme and a comprehensive range of welfare and recreational amenities. Assistance will be given towards expenses involved in moving to the Bedford area, where appropriate.

Applications should be made in writing, giving details of age, past experience and present salary to:

THE PERSONNEL MANAGER
(Ref 1604C/9),
QUEENS ENGINEERING WORKS,
BEDFORD.

E5175 A

## BICC

have an interesting and progressive post to offer a

## RUBBER TECHNOLOGIST OR CHEMIST

qualified to degree standard or equivalent, at their Wiring & General Cables Division at Leigh, near Manchester. The work involves the development of natural and synthetic rubber compounds and their utilisation in the electric cable industry. Previous experience is desirable but not essential. Salary according to age and experience. Staff superannuation scheme in operation. Written applications, stating age, experience and qualifications, should be addressed to:—

THE PERSONNEL OFFICER,
BRITISH INSULATED CALLENDER'S CABLES, LTD.,
ANCHOR WORKS, LEIGH, LANCS.

E5172 A

## DESIGN DRAUGHTSMEN

required for Material Handling Division, experienced men preferred but not essential provided qualifications and engineering background are suitable. Pleasant working conditions and canteen facilities. Write stating age, experience and salary required to The Secretary, British Jeffrey-Diamond Ltd., Stennard Works, Wakefield.

E5174 A

Mullard

## MULLARD SOUTHAMPTON WORKS

have a vacancy for a

## GRADUATE ENGINEER

to join their rapidly expanding Plant Department. The department services an establishment concerned with research, development and quantity production of transistors, and the post calls for a man capable of progressing to a senior appointment. A post graduate apprenticeship or sound practical experience are therefore essential. The position offers an opportunity to extend practical knowledge in a very wide variety of engineering services within a large and expanding group of companies.

**Please apply in writing to the Plant Personnel Officer, Mullard Southampton Works, Millbrook Industrial Estate, Southampton, quoting the reference C.14.**

"Mullard" is the Trade Mark of Mullard Limited. E5194 A

## COMPANY MEETING

# WORTHINGTON-SIMPSON LIMITED

## ENCOURAGING PROSPECTS

The Sixty-ninth annual general meeting of Worthington-Simpson Ltd., was held on June 23 in London, Sir Samuel R. Beale, K.B.E., M.I.Mech.E. (Chairman of the company), presiding.

The following is an extract from the chairman's statement circulated with the report and accounts for the year 1959.

It gives me much pleasure to present to you the results of another year's satisfactory operations. I say, satisfactory, notwithstanding a drop of £163,428 in the Trading Profit to £1,018,246 compared with last year's figure of £1,181,674. After full provision for all charges, including taxation, a net profit for the year under review of £476,051 is shown against £543,759 for 1958.

In my Statement which accompanied the 1958 Accounts I prepared you for a decline in profits. I then stated our profits in recent years have been influenced by the closing of long-term contracts for condensing and feed-heating equipment and warned you that as no such similar contracts were scheduled for completion during 1959, our profits would settle at a lower level. My forecast has proved to be correct, but nevertheless the decline in profits is not so great as was anticipated due mainly to a marked increase in the sales of our standard products.

During 1959 we both sold and produced more of our standard ranges of equipment than ever before and I am pleased to say that so far this year the trend continues as a result of which our order book remains at its usual high level.

Since my Statement last year we have, on the heavy plant side of our activities, obtained two most valuable contracts from the Central Electricity Generating Board for condensing and feed-heating equipment for Bankside Power Station, London, and condensing plant for West Thurrock Power Station, Essex. These are a direct result of your Board's endeavours to ensure a continuity of this class of business.

Prospects for 1960 are encouraging, particularly as fairly substantial shipments of equipment for the £2 million contract for the new power station at Buenos Aires will be made during the course of the year.

In view of these prospects and the continued liquid position of your Company, your Board feels a slightly higher distribution of profits is justified and accordingly recommends that the final dividend on the Ordinary Capital be 12½ per cent less tax, making with the interim dividend of 7½ per cent. less tax, paid last December, a total of 20 per cent less tax, for the year.

In closing, I know you will once more wish me to take this opportunity of expressing your thanks to all concerned in the Organisation for the excellent work which they have done for the Company during the past year.

The report and accounts were unanimously adopted and the dividend, as recommended, was approved.

Classified Advts. continued on page 138

SITUATIONS VACANT

MSL *have been retained to advise on the appointment of a*

## COMPANY ENGINEER

for a manufacturing and mining company with 1,700 employees. Its high grade refractory products are used in the iron, steel and heat-using industries throughout the world.

The holder of this new post will be responsible independently to the Board for ensuring that existing and new plant and methods are operated efficiently and for advising on the design, purchase and installation of new equipment. He will co-operate with the Works Managers in the programming of maintenance and repairs and may be required to re-organise the engineering departments with 200 staff.

Candidates must be professional engineers with broad experience in medium industry. Experience of production and control and costing systems is essential.

Preferred age 35 to 40 years. Initial salary £2,000 to £2,500, with pension and life insurance. A car and rented house will be supplied by the Company.

Please send brief details in confidence, quoting reference G.2427, to D. C. Duncan. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

**MANAGEMENT SELECTION LIMITED**
**212, West Regent Street, Glasgow, C.2.**

E134 A

SITUATIONS VACANT

## BRITISH TRANSPORT COMMISSION

require in the department of the Chief Electrical Engineer, Melbury Terrace, Marylebone, London, N.W.1. a Qualified Engineer to assist in the specification and design of the overhead line contact system, including supports and ancillary equipment, for A.C. railway electrification. Experience in design and installation of the catenary system particularly desirable.

**Salary range £1095 to £1210**

Superannuation Scheme, certain travel facilities, medical examination; Write stating age, qualifications and experience to the Director of Establishment, British Transport Commission, 222, Marylebone Road, London, N.W.1. within 14 days.

E5124 A

SITUATIONS VACANT

## ARE YOU A QUALIFIED ENGINEER

with practical experience, a scientific bent and an enquiring mind?

We are looking for such a person, age 25-35, to undertake research on the fundamental aspects of grinding. Minimum qualification is H.N.C. or equivalent in Engineering.

This is a good opportunity in an aspect of our work which is expected to expand, and prospects for the right man are therefore excellent.

First-class conditions of service, including contributory pension and life insurance scheme.

Please apply, giving age and full details of qualifications and experience to:—

**Personnel Manager,**
**Universal Grinding Wheel Co., Ltd.,**
**Stafford.**

Applications treated in strictest confidence.

E5158 A

SITUATIONS VACANT

## ENGINEERING DESIGNERS

Attractive positions are available to experienced designers in connection with the expansion of our ranges of machines for new developments in the mechanisation and automation of sewage treatment plants and for other products of this company. Experience in this particular field is not necessary.

**NORSTEL & TEMPLEWOOD HAWKSLEY LTD.**
2 BUCKINGHAM AVE., TRADING ESTATE, SLOUGH.

E5183 A

## DESIGN ENGINEERS/ DRAUGHTSMEN (DEVELOPMENT)

are required to give technical assistance on plant, product and production problems within the Company's Engineering Development programme.

The responsibility of one position includes the general supervision of the work of a small team of Draughtsmen.

Candidates should be about 35 years of age with at least an O.N.C. and preferably an H.N.C. in Mechanical Engineering. Their experience should be such as to give them a working basis for approaching with confidence new and interesting engineering problems. The salary scale is attractive and the appointments are pensionable.

Please reply giving full details of age, education, qualifications and experience to:

**The Staff Officer**
**Newton, Chambers and Co. Ltd.,**
**Thorncliffe,**
**Near Sheffield.**

E5178 A

FIBREGLASS TRADE MARK

## RESEARCH AND DEVELOPMENT MECHANICAL ENGINEERS

If you have a good honours degree in Mechanical Engineering and would like to hold a responsible job in an expanding industry, you are invited to write about yourself to **Mr. A. de Dani, Manager, Research and Development, Fibreglass Limited, St. Helens, Lancashire.**

You would be given varied and interesting work on all process and product development on existing plant and design and operation of new plant and processes. Based on St. Helens you would have occasion to visit works in Glasgow and Birkenhead.

E5170 A

## HENRY WIGGIN & COMPANY, LIMITED HOLMER ROAD, HEREFORD

require a

## MECHANICAL ENGINEER

to augment a team of Engineers at present engaged in a substantial expansion and modernisation scheme. This work should lead, in 3/4 years time, to a responsible position in either the Engineering or Production Departments.

Applicants, preferred age 28/35, should possess either an Engineering Degree, Corporate Membership of the Institution of Mechanical Engineers, or equivalent qualification. They should have had a first class practical training. Experience in rolling mills and ancillary equipment, or heavy hydraulic equipment, would be an advantage.

Attractive salaries, commensurate with age and experience, will be paid.

The Company provides excellent Canteen, Recreational and Welfare facilities, operates generous Non-Contributory Pension and Life Assurance Schemes and, in appropriate cases, assistance can be given for housing.

Applications should be made in writing, giving details of education and experience, and should be addressed to The Personnel Manager, quoting Ref. P.8.

E5167 A

## PROFESSIONAL ENGINEER

required at

**ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL**

To assist in the organisation and control of :—

1. The mechanical installation and servicing of experimental apparatus, bubble chambers and related plant associated with the 7GeV Proton Synchrotron and allied Laboratories.
2. Precision survey and alignment of the main plant and experimental equipment.

Applicants should have served an engineering apprenticeship and experience in metrology and the use of optical measuring instruments would be an advantage.

**SALARY: £860 (at age 25) — £1,340 p.a.**

Housing and superannuation schemes.

Send POST CARD for details to Personnel Manager (1724/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E5168 A

## CHIEF ENGINEER

for the main mill of an independent company of fine paper manufacturers in the North-west employing 1100. This is a substantial company operating very modern plant by up-to-date management practices in attractive surroundings. Starting salary £1750-£2250 together with a car. Pension Scheme. Residential facilities are excellent and conveyance charges and cost of furniture removal will be met.

The Chief Engineer will report to the Director of Engineering and be responsible for the organisation and control of a substantial maintenance department. The essence of this appointment is to ensure that the very modern equipment of the mill is in condition to operate continuously 7 days per week, 50 weeks per year, and that the cost of maintenance is economic. In addition, there is a considerable amount of development and enlargement work to be carried out in the foreseeable future, in the main by company labour.

Among the desired qualifications are not less than 7 years' experience in control of the maintenance of paper-making machinery, including continuous 7 day operation; personal experience of the operation of planned maintenance; First class professional qualifications required. Age 35-40 years.

Please write briefly in first instance, quoting Reference Number 752, to :—

AA LTD

**ASHLEY ASSOCIATES LTD.**
**PETER HOUSE, MANCHESTER 1.**
RETAINED TO ADVISE ON THIS APPOINTMENT
*The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.*

E5223 A

SITUATIONS VACANT

## STANDARDS ENGINEER

is required by the
**UNITED KINGDOM ATOMIC ENERGY AUTHORITY**
at Windscale and Calder Works, Cumberland

to be responsible to the Chief Design Engineer for establishing, and the implementation of, standards and specifications for a wide range of mechanical and electronic equipment.

Applicants must have served a recognised engineering apprenticeship or have had comparable training and be corporate members of a senior engineering institution or equivalent. An electrical qualification or experience of electrical work would be an advantage. It is essential that applicants should have the knowledge, experience and personal qualities required to set up a Standards Organisation, wide general experience in practical engineering and specialised experience in standardisation.

Salary within the scale £1880 to £2180 according to qualifications and experience. Contributory Superannuation. Staff Housing Scheme.

Send postcard for application form, quoting reference P/W.32/J/, to Recruitment Officer, U.K.A.E.A. Production Group, Windscale Works, Sellafield, Seascale, Cumberland.

**Closing Date 25th July, 1960.** E5213 A

SITUATIONS VACANT

## CHIEF INSPECTOR

A leading machine tool maker in the Midlands invites applications for this important post.

Applicants should preferably be not more than 45 years of age, with a professional qualification or equivalent and with practical knowledge of modern inspection methods.

The person appointed will be directly responsible to the Works Director for the maintenance of a high standard of quality control.

The salary will be commensurate with the importance of this key position.

Applications, which should be as detailed as possible, should be sent marked Private and Confidential to Box No. E2906, "The Engineer."

A

SITUATIONS VACANT

CONSTRUCTORS JOHN BROWN LIMITED
require a
***SENIOR***
## ELECTRICAL ENGINEER

Applicant must be a Corporate Member of the I.E.E. with design experience in industrial electrical work and, preferably, power supply experience. 5-day week, good salary and contributory pension scheme.

*Please apply, giving full details, to:*
*The Personnel Manager,*
**CONSTRUCTORS JOHN BROWN LIMITED,**
**C. J. B. House, Eastbourne Terrace, Paddington, London, W.2.**
*quoting ref. no. 1 7059*

E5205 A

SITUATIONS VACANT

## JAMES BOOTH ALUMINIUM LIMITED,

**ARGYLE STREET, NECHELLS, BIRMINGHAM, 7**

Due to a large development scheme, require MECHANICAL ENGINEERING DESIGNER DRAUGHTSMEN, able to work with minimum of supervision and must have at least O.N.C.

Possibility at later stage of developing into Equipment and Methods Engineer.

Good salary, Contributory Pension Scheme, three weeks holiday after 12 months service. Holiday arrangements this year will be honoured. Interviews can be arranged at week-ends if desired.

E5214 A

SIMMS MOTOR & ELECTRONICS CORPORATION LTD.
require the services of a

## PATENTS ENGINEER

The Applicant should preferably be a Chartered Patent Agent and should be able to deal with all aspects of patent applications in connection with the company's products which cover the field of hydraulics, electrical machines, electronics and aerodynamics. He should also be capable of dealing with legal matters associated with licencing arrangements.

Applications should be submitted to the Technical Director at:—

SIMMS MOTOR UNITS LIMITED,
The Grange, East Finchley, London. N.2.

E5204 A

***Would you like to work in a peaceful atmosphere with beautiful country around you?***

**Group of Engineering Companies with modern offices in Hereford require:**

(1) Technical and Commercial Sales Manager with experience of industrial air conditioning and refrigeration for home and export.

(2) Development Engineer.

(3) Sales Engineers.

(4) Refrigeration, Mechanical and Hydraulic Draughtsmen and Estimators.

5 day week. Contributory pension scheme. Applications, which will be treated in strict confidence, should be made in writing stating age, experience, salary required, &c., to Managing Director, Denco Works, Hereford. E189 A

## CENTRAL ELECTRICITY GENERATING BOARD

### PLANNING DEPARTMENT

### Headquarters, London, S.E.1.

### SENIOR ASSISTANT ENGINEER (HYDRO-ELECTRIC)

required in the **Hydro, Industrial and District Heating Section of the Station Planning and Development Branch.**

The Section is concerned with the planning of new hydro-electric generating plant in England and Wales. It is responsible for the investigation and selection of sites for hydro-electric and related projects including their economic assessment and subsequently their evolution in principle. It is also responsible for the negotiations for statutory and other consents.

**The engineer appointed to this position would be responsible to the Hydro, Industrial and District Heating Engineer.** Candidates should possess an Honours degree or the requisite qualifications for corporate membership for the Institutions of Civil, Mechanical or Electrical Engineers. A sound engineering or scientific background in hydro-electric work is essential. It will also be an advantage if candidates have been engaged in the preparation of initial project reports and estimates for such schemes and/or have experience in hydro-electric construction.

**Salary within the range £1,590-£1,940 p.a.**

**Applications stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 4th July. Envelopes should be marked "Confidential Ref. ENR/220."**

E5188 A

## DRAUGHTSMEN

Draughtsmen are required at the Midlands Research Station, Solihull.

The duties are interesting and will include work on the design of pilot and prototype plant associated with the development of new high-pressure processes for the production of town gas.

Candidates should possess at least an O.N.C. certificate in Mechanical Engineering.

The salary for the appointments, which are pensionable and subject to medical examination, will be within the range of £733–£927 per annum.

*Applications, stating age, education and experience, should be addressed to the Industrial Relations Officer,*

**WEST MIDLANDS GAS BOARD,**
**6, Augustus Road, Edgbaston, Birmingham, 15.**

E190 A

## BICC

### MECHANICAL ENGINEERING
AND
### PLANT LAYOUT DRAUGHTSMAN

required, 25/35 years of age, with good engineering background. Experience in general cable making machinery detailing and/or cable factory plant and services layout, whilst not being essential, would be an advantage. Five day week. Excellent working conditions. Staff Superannuation Scheme in operation. Write, stating age, experience and qualifications, to :—

THE PERSONNEL OFFICER,
BRITISH INSULATED CALLENDER'S CABLES, LTD.,
ANCHOR WORKS, LEIGH, LANCS.
E5203 A

## SITUATIONS WANTED

**COMPANY MANAGER (47), A.R.T.C., A.S.M.A.,** returning to U.K. from Africa in July seeks position in SALES or MANAGEMENT. Experienced in Earthmoving, Mechanical Handling, Hydraulics and Electrical Equipment. Widely travelled in Europe, Africa and Far East.—Enquiries please to BOX No. E2888, "The Engineer." B

**TECHNICAL SALES REPRESENTATIVE** (36). 6½ years experience, good apprenticeship and technical background, seeks position offering scope and advancement with progressive firm. At present based Coventry.—BOX No. 2900, "The Engineer." B

**B.MECH.E. (IST CLASS), H.N.C. ELEC. (DISTINCTIONS),** 27; 2½ years in U.K., 2 years in Denmark, Sweden, Holland, Spain and France. Mechanical and Electrical, seeks post in India.—BOX No. E2905, "The Engineer." B

**ENGINEER,** 33, M.A. (Cantab.), G.I.Mech.E., A.I.L., on Sales Staff of Heavy Engineering firm, seeks interesting, responsible position where his qualifications and experience can be fully utilised, possibly by a firm anxious to expand export trade, especially to outer Seven countries and inside Common Market. Mechanical Apprenticeship, several years' experience fabrication, design, testing and commissioning Pressure Vessels and Steam raising plant. Professional qualifications in French and Swedish (Associate Institute of Linguists), some Spanish and German. Working in London. —Box No. E2911, "The Engineer." B

**MECHANICAL ENGINEER,** A.M.I.Mech.E. Age 36 years, desires to represent British company at home or overseas. "Solids" pumping specialist. At present in Africa. British, married, two children. —BOX No. E2910, "The Engineer." B

## SUB-CONTRACTING

**KELLERING AND CAM PROFILING** capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

## PATENTS

**THE PROPRIETOR** of British Patent No. 770363, entitled "BLIND RIVETING," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 140 S. Dearborn Street, Chicago 3, Illinois, U.S.A. E5201 H

## FOR HIRE

**LATTICE STEEL ERECTION MASTS** (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

**Classified Advts. continued on page 140**

## MISCELLANEOUS

### LUSOL
**KILLS RUST AND LUBRICATES**

LUSOL The Rust Solvent is invaluable for Dismantling, Repairing and Overhauling Engineering Equipment. Obtainable from your usual Supplier. Enquiries to the manufacturers :—

**The Great Eastern Oil Co., Ltd.,**

372, Scotland Street, Glasgow. Tel.: South 2207
E184 I

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**MOBILE LIFTING SERVICE.** Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 78481. E186 I

## BUSINESS OPPORTUNITIES

**A BARGAIN.** £25 complete. BRAND NEW READY-MADE CO. REGNS. Guaranteed no trading (ENGLAND OR SCOTLAND)—all trades available NOW, including Engineering ; Electrical Engineering ; Motor Engineering ; Garage ; Machinery ; Metal ; Haulage ; Hire Purchase ; Investment ; Property (specially prepared for each trade).—BUSINESS ECONOMY CO. REGNS., LTD., Dept. T/16, 156, Strand, London, W.C.2. (Tem. 8377/2294), for English companies, and to 19, Walker Street, Edinburgh, 3 (Cal. 1167/8/9), for Scottish Companies. Read "ADVANTAGES OF TRADING AS A LIMITED COMPANY" (3s. post free) ; Limited Co. may save you tax. We have seven-day Co. Regn. service with your own choice of name. £21 complete, plus stamp duties.
E182 G

## MACHINERY Etc. WANTED

**URGENTLY REQUIRED**

Oil-fired BOILER PLANT, either Vertical or Horizontal, capacity, 2500–3500 lbs. per hour, working pressure minimum 150 p.s.i. Complete with oil-firing equipment, all controls, &c.—Full details, prices, &c., to BOX No. E5233, "The Engineer." F

## WANTED

**300 / 400 Ton Forging Press,** Steam preferred, Hydraulic or Pneumatic considered, for Cogging and Forging up to 10 Cwt. — Box No. E5186 "The Engineer".

F

## FOR SALE

**HYDRAULIC PRESSES**

NEW 1000-TON HUGH SMITH (POSSIL) LTD., 4-column Upstroke, ram 25½in. diameter, stroke 5ft., daylight 10ft., table area 10ft. by 10ft., motor-driven Towler Electraulic Pumps operating at 4500 lbs p.s.i. w.p.

500-ton FIELDING AND PLATT 4-column DOWNSTROKE, stroke 24in., daylight 65in., between columns 34in. by 24in., Fraser OLS30 Hydraulic Pumps, 3200 lbs. p.s.i. w.p.

200-ton FAWCETT PRESTON 4-column DOWNSTROKE, stroke 24in., 26½in. between columns.

190-ton SHAW 4-column UPSTROKE PLUNGER PRESS, main ram 19in. diameter by 17in. stroke, downstroke plunger, ram 8in. diameter, 36in. between columns.

100-ton FIELDING AND PLATT 4-column DOWNSTROKE, stroke approximately 6ft., daylight 8ft. 3in., working area 25in. by 27in., Fraser OLS30 Hydraulic Pump, 3200 lbs. p.s.i. w.p.

**THOS. W. WARD LTD.**

ALBION WORKS - - - - - SHEFFIELD
'Phone : 26311. E215 G

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**QUICKSILVER.**—Highly competitive quotation upon request for all grades of quicksilver for use in every type of industrial and scientific work.—Belgrave (Mercury) Limited (E), 5, Belgrave Gardens, London, N.W.8. MAI 3826. E9594 G

## FOR SALE

### FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New) 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100 150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstubes, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

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OVERHEAD CRANES.—25-ton Girders and end carriages, with 60 h.p. motors, 95ft. 10in. span ; 30-ton Vaughan, 42ft. 3in. span ; 25-ton Clyde, 21ft. 9in. span, new 1954 ; 20-ton Vaughan, 42ft. 3in. span, 6-ton auxiliary, cab control (5) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; Wharton, 7½-ton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V. d.c. (3) ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.

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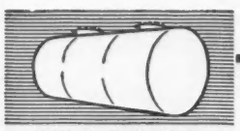

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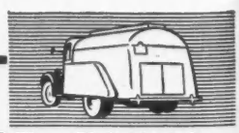

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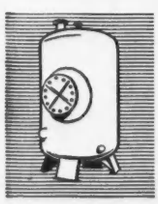

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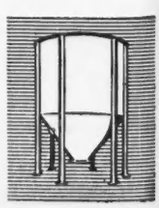

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*By Order of the Secretary of State for War*

## GOVERNMENT SURPLUS STORES

**SALES BY AUCTION**

| | | *Main Location* | *Auctioneers* |
|---|---|---|---|
| June 30 | Miscellaneous stores and machine tools including :— | M.O.A. Storage Depot, Rotherwas, Hereford. | RUSSELL, BALDWIN & BRIGHT LTD., (Dept. L), 20 King Street, Hereford. (Tel.: 4366). |
| | Tyres ; tubes ; lathes ; universal milling polishing and grinding machines ; electric stacking, fork lift and platform trucks ; low loader ; hand lifting trucks ; generator (diesel) ; Morris cranes ; 2 diesel locomotives ; ratchet jacks 12 and 15 ton ; chain blocks ; steel rails 124 tons ; telephone sets ; M.T. spares, etc. | | |
| July 5-6 | Machine tools and miscellaneous stores. | M.O.A. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18. | FULLER, HORSEY, SONS & CASSELL, (Dept. L), 10, Lloyd's Avenue, London, E.C.3 (Tel.: Royal 4861). |
| July 12-15 | Vehicles, motor cycles, earth moving and lifting equipment. | M.O.A. Storage Depot, Ruddington, Notts. | WALKER, WALTON & HANSON, (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272). |
| July 15 | Miscellaneous stores. | Returned Stores Group, Reed Hall, Colchester, Essex. | FENN, WRIGHT & CO., (Dept. L), 146 High Street, Colchester, Essex. (Tel.: 3171). |
| July 19 | Miscellaneous stores and vehicles. | Central Ordnance Depot, Bicester, Oxon. | MIDLAND MARTS LTD., (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73). |
| July 26 | Machine tools and miscellaneous stores. | M.O.A. Storage Depot, Byley, Nr. Middlewich, Cheshire (Sale at Cheetham Town Hall, Manchester 8.) | J. H. NORRIS & SON, (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373). |
| August 16 | Miscellaneous stores. | M.O.A. Storage Depot, Ruddington, Notts. | WALKER, WALTON & HANSON, (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel. 54272). |
| August 23 | Miscellaneous stores. | Central Ordnance Depot, Didcot, Berks. | SIMMONS & SONS, (Dept. L) 12 Station Road, Reading, Berks. (Tel.: 54025). |

Application for catalogues, available 14 days prior to date of sale should be made *only* to the auctioneers shown above (price of catalogue 1s. 0d. P.O. only).

E118 J

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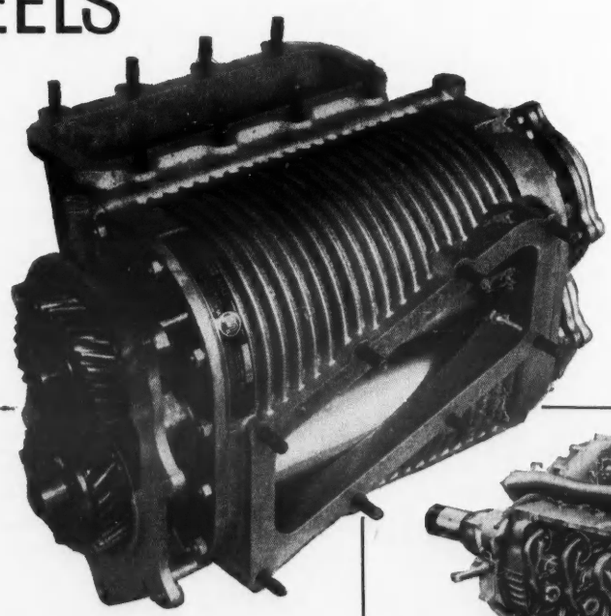
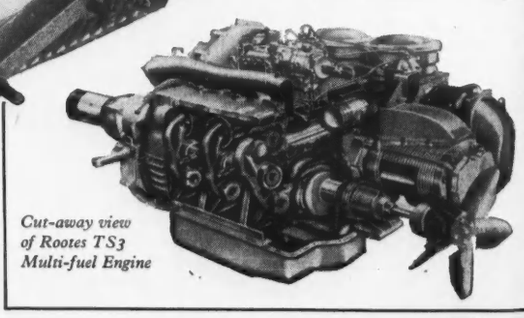


*Wade supercharger*



*Cut-away view of Rootes TS3 Multi-fuel Engine*

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|---|---|---|---|---|---|
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| 1½ in. dia. | Oil quenched 850°C tempered 510°C | 79 | 83 | 15 | 28 |
| 1½ in. dia. | Oil quenched 850°C tempered 560°C | 68 | 73 | 19 | 55 |
| 2½ in. dia. | Oil quenched 840°C tempered 650°C | 57 | 64 | 20 | 65 |
| 5½ in. dia. | Oil quenched 830°C tempered 650°C | 50 | 58 | 19 | 75 |

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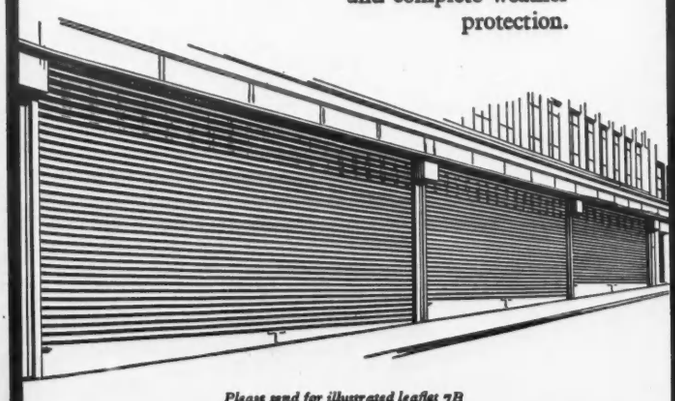

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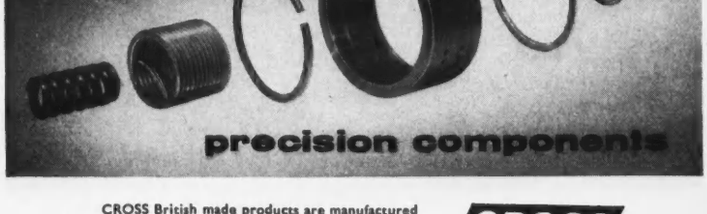

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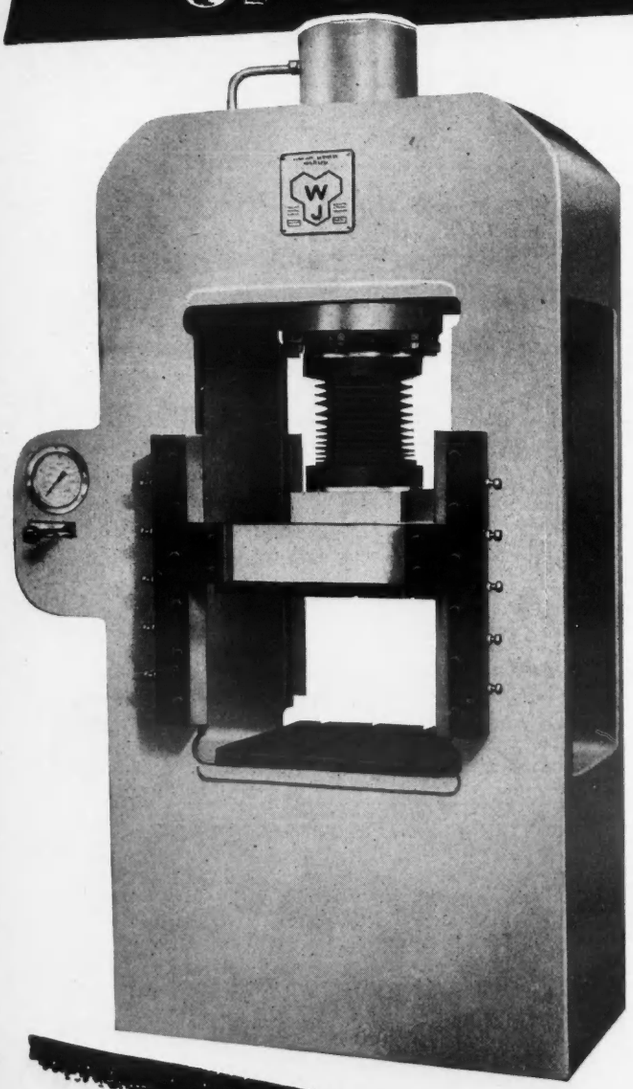

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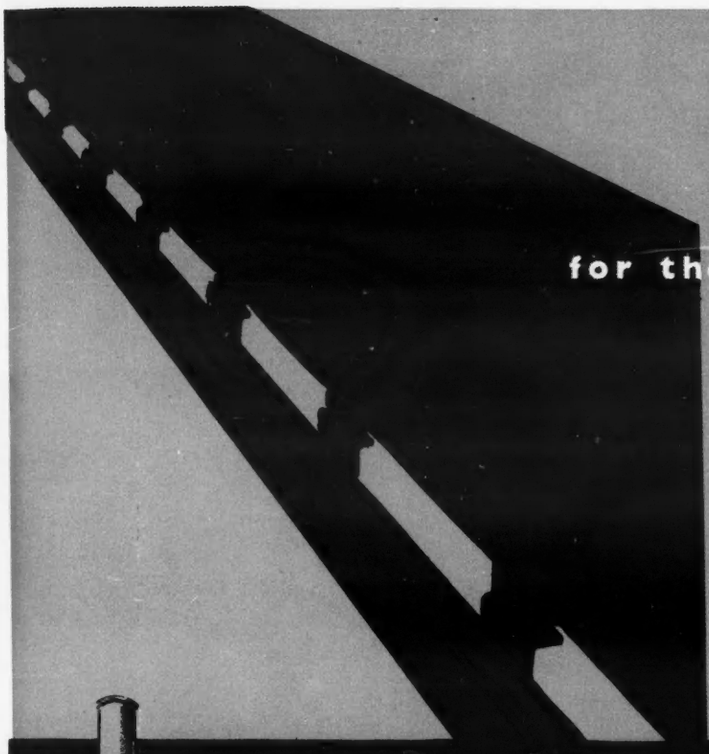

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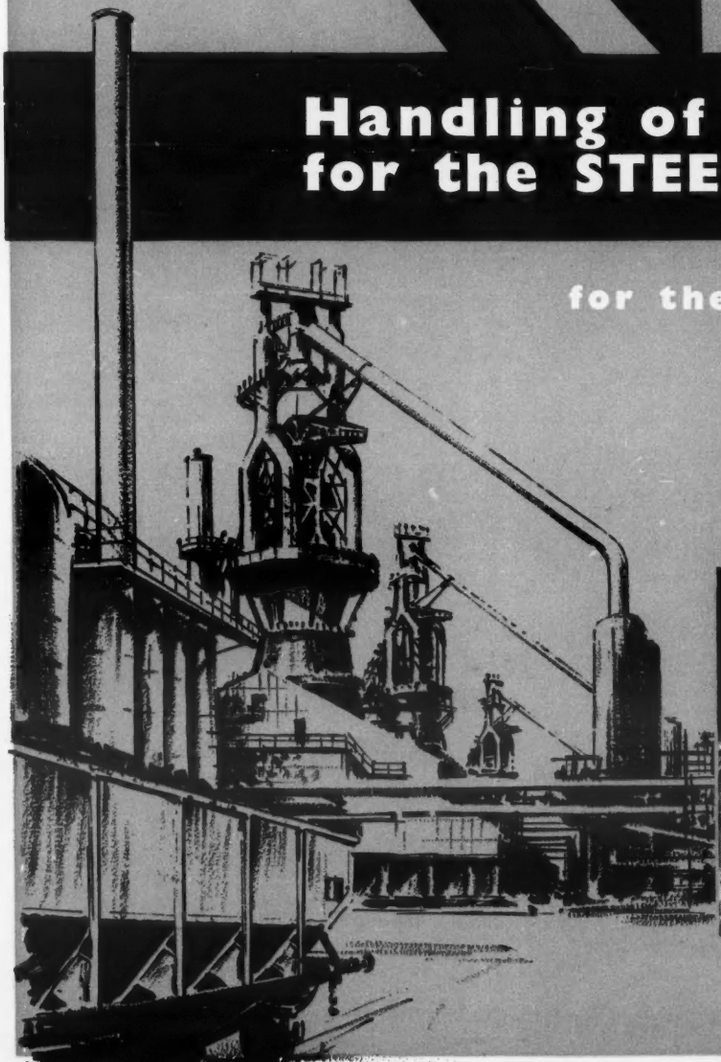

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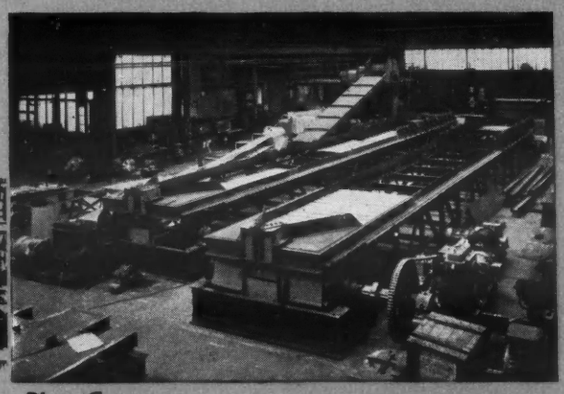

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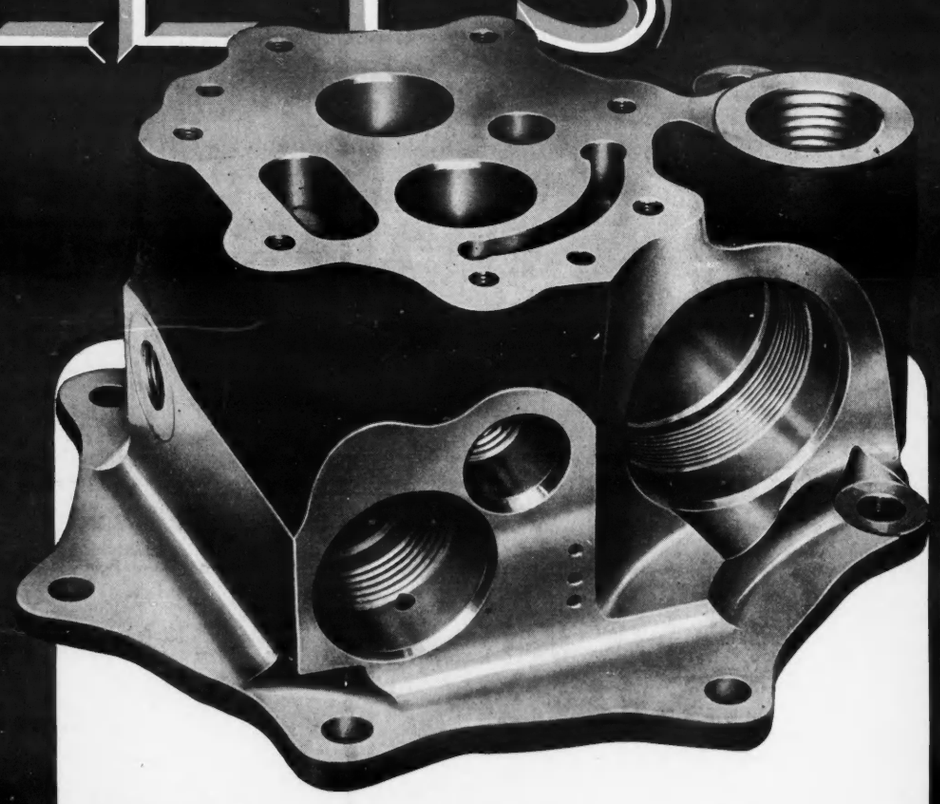

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